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BIRD STRIKE Committee EUROPE 18Th MEETING -- PT. 2

DOCUMENT IDENTIFICATION

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REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	1986	Conference Proceeding 26-30 May 1986

4. TITLE AND SUBTITLE
Bird Strike Committee Europe (BSCE) , 18th Meeting, Copenhagen, Denmark
26-30 May 1986. Part II

5. FUNDING NUMBERS

6. AUTHOR(S)
Bird Strike Committee Europe

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Bird Strike Committee Europe
Civil Aviation Administration
Aviation House
Ellebjergvej 50
DK-2450 Copenhagen SV, Denmark

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Bird Strike Committee Europe

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES
Copyright waived per email from Willemijn Prast, Sent: Wednesday, September 01, 1999,
To: Short, Jeffrey, USAF IBSC Representative, Tyndall AFB, FL 32403.

12a. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for Public Release; Distribution Unlimited

12b. DISTRIBUTION CODE

A

13. ABSTRACT (Maximum 200 words)

The Bird Strike Committee Europe consists of civil and military participants from Europe with a common interest in the bird strike problem. Attendence is open to participants from other parts of the world. Annual Meeting Proceedings include Chairman's Report, Working Group Reports and Papers Presented:

TABLE OF CONTENTS:

14. SUBJECT TERMS
Bird Strikes, Aviation Safety, Airports, Hazards, Survivability, BSCE, International Bird Strike Committee, IBSC

15. NUMBER OF PAGES
135-468

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19, SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	UL

NSN 7540-01-280-5500

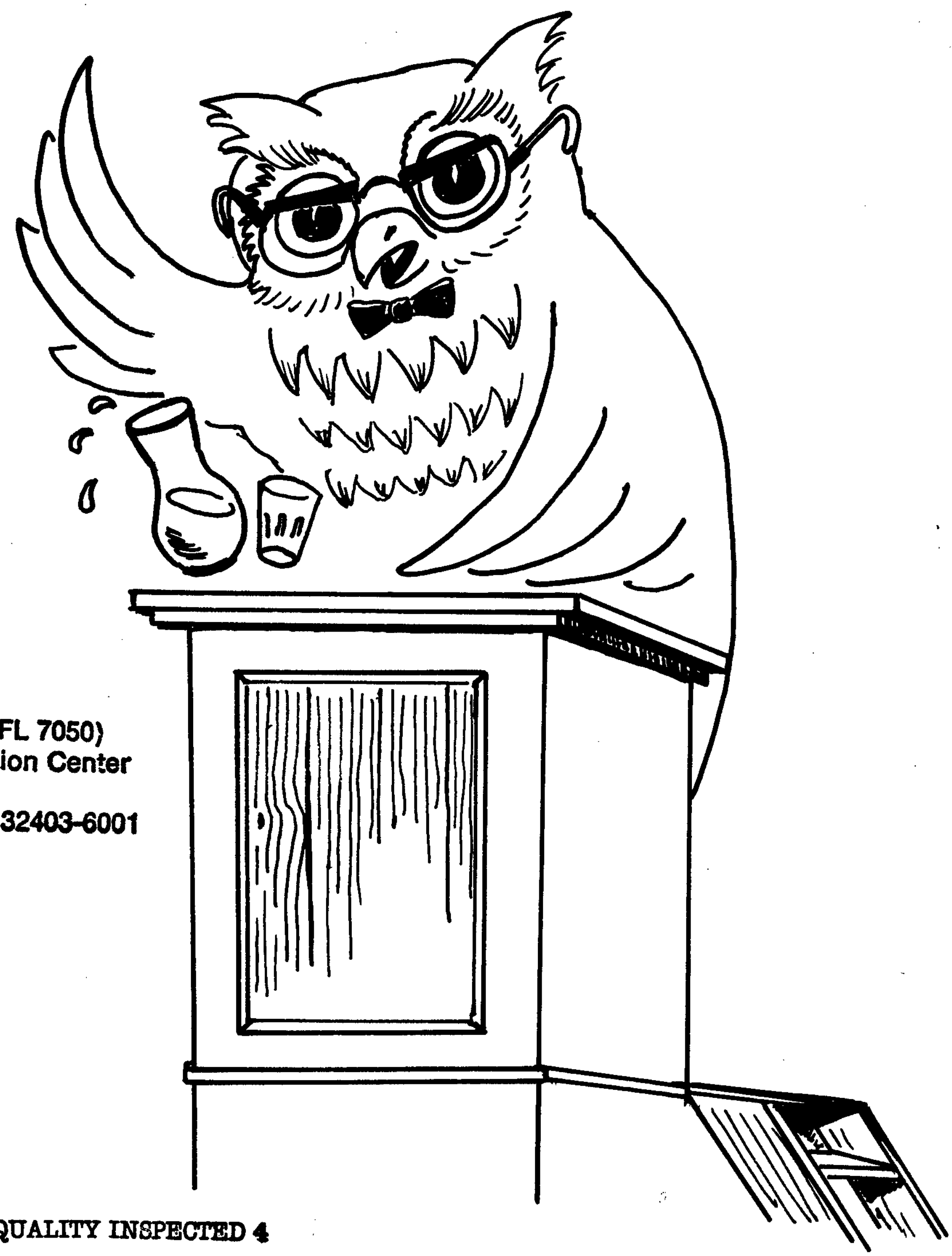
Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18
298-102

BIRD STRIKE COMMITTEE EUROPE

18th MEETING

COPENHAGEN, 26 - 30 MAY 1986

PART II



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TO ALL PILOTS - WATCH OUT FOR BIRDS !!

BIRD STRIKE
COMMITTEE EUROPE

CIVIL
AVIATION ADMINISTRATION

Date: February 1987

Our ref.: Da/KFM

Contact person:

Your letter of:

Your ref.:

Info:

Dear friend and colleague,

./. Enclosed you will find the second part of the report on the 18 BSCE meeting held in Copenhagen, 26-30 May 1986.

Yours faithfully,

H. Dahl
Chairman

Luftfartshuset Box 744 50 Ellebjergvej DK-2450 Copenhagen SV Denmark
Phone +45 1 44 48 48 Telex 27096 Telefax +45 1 44 03 03 Office hours 9.00 - 15.00

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ADF616057

BSCE 18/ WP 7 REVISED
Copenhagen May 1986

BIRD HAZARD WARNING USING NEXT GENERATION WEATHER RADAR

Captain Russell P. DeFusco, United States Air Force
Dr. Ronald P. Larkin, Illinois Natural History Survey
Dr. Douglas B. Quine, Illinois Natural History Survey

HQ Air Force Engineering and Services Center
Tyndall AFB, Florida 32403-6001

Abstract

United States Air Force Bird-Aircraft Strike Hazard (BASH) Team is sponsoring research to utilize an algorithm designed to detect birds on the nation-wide Next Generation Weather Radar (NEXRAD) system currently being developed. A phased approach to the task of algorithm development separates flying radar targets into several classes: waterfowl, passerines, blackbird roosts, gulls, raptors, bats, and insects. Data was collected for all classes and a draft algorithm was prepared for waterfowl in the first phase. A second phase is underway to test the waterfowl algorithm and to draft and compare a migratory passerine algorithm. Research has confirmed that the NEXRAD system can distinguish the different classes of targets and can distinguish birds from weather. Ultimately this system will provide real-time bird hazard warning information on a continent-wide scale.

1. Introduction

A comprehensive new system of weather radars, termed the Next Generation Weather Radar (NEXRAD) is being built in the United States. The NEXRAD system (Figure 1) is designed with the goal of identifying dangerous and economically significant weather patterns automatically, including tornadoes, hurricanes, hail, and flood-producing rains. In 1982, the Bird Aircraft Strike Hazard Team at Tyndall Air Force Base began to investigate the possibility that this powerful radar system could be used to identify birds also. This paper will discuss the potential of the NEXRAD radar system to warn pilots automatically of potentially hazardous flying birds.

Research to determine the feasibility of automatic recognition of birds and to program such ability into the NEXRAD system is being carried out by the Illinois Natural History Survey in Champaign, Illinois, USA.

In the remainder of the paper we describe the essentials of the NEXRAD radar system and its capabilities, show the appearance of some bird targets and weather targets on NEXRAD, touch upon the real time warning aspect of the project and finish with a film of "Ring Angels" on a NEXRAD-like radar.

The Next Generation Weather Radar System presently is in the advanced stages of prototype development, scheduled to be completed in the early 1990's. NEXRAD will be based on a large S-band pulsed Doppler radar with a narrow beam and great power (1 megawatt) and sensitivity (90 dB dynamic range). This radar is pictured as the Radar Data Acquisition Subsystem of NEXRAD. It is important that there are two other subsystems in NEXRAD, the Radar Products Generation Subsystem, and the Principal User Processor Subsystem. NEXRAD is designed to be heavily computerized, and all displays of NEXRAD information available to users are derived from computer displays. For automatic processing of weather data, large computer programs are being written to analyze the digital NEXRAD weather data while the data are being acquired and make decisions on hazardous winds and rain. NEXRAD processing will also be available for making decisions on bird targets within the range of NEXRAD radars; because birds usually avoid severe weather, we expect that considerable processing time will be available when severe weather is absent.

NEXRAD radars (about 170 of them) will provide coverage of a large part of the Continental United States. A few other NEXRAD radars will be located at U.S. military installations and NATO facilities outside the Continental United States.

II. Bird Targets on NEXRAD Prototype Radars

Large Doppler radars, similar in characteristics to NEXRAD, are used for meteorological research in several places in the United States. Here we present color images of flying birds on some of these research radars and show that the NEXRAD radar certainly will be able to detect birds and that distinguishing birds from weather is possible.

NEXRAD can detect birds out to remarkable distances. For instance, calculations show that a single Herring Gull would be visible as a faint target at a distance of 450 km. It is clear that other factors, such as interfering ground clutter and the curvature of the earth, are more important than sensitivity in determining NEXRAD's range in detecting birds of this size.

Echos of song birds during migration often extend out to beyond 100 km on NEXRAD images.

In Figure 2, velocities of migrating birds are visible covering much of the New England region. The radar at the center of this image is located at the Massachusetts Institute of Technology and all of the radar echoes appearing on the map are migrating birds. The radar measures the radial velocity of the birds and, because the birds are flying in a southerly direction in the fall, birds on the top half of the image are receding away from it. The speed of these targets, which includes the speed of the wind, is about 13 meters per second.

Sometimes birds appear as complete sheets on these NEXRAD images (Figure 3). The migrants in this image taken from the Air Force Geophysical Laboratory also in Massachusetts, appear in all directions. Because the 4^{o} elevation of the radar slants up through the dense layer of migrating birds, and because the wind is exhibiting shear with altitude, the velocities show that the directions of the higher birds are different from the directions of the lower ones. Note the small cloud somewhat higher than the bird images, to the southwest. The targets in this photograph were more than half waterfowl. This is known from wingbeat records and tracks of individual birds taken concurrently with a small tracking radar unit operated by the Illinois Natural History Survey and co-located with the NEXRAD prototype radar.

We now turn our attention from the general appearance of widespread bird hazards on NEXRAD radars to the potential methods of distinguishing such bird targets from other targets such as weather. Although insects, moving ocean waves, and other kinds of targets must also be discriminated from birds, distinguishing precipitation, clouds, and other weather echos is more important than attempting to assess bird hazards using these radars. As shown in Figures 4 and 5, weather often has distinctive characteristics on radar. These post-cold-front clouds are rather uniform patches of echo extending to rather high altitudes. Often their echos on radar are much stronger than echos of birds because clouds fill huge regions with water, whereas birds package their water in feathery bundles. Clouds also move at the speed of the wind and pay little attention to time of day, topography, or the appropriate migratory direction, unlike birds.

In Figures 6 and 7, images of bird show the opposite characteristics; they are inhomogeneous (a characteristic we have begun to call "stipple"), less intense in their echos, and sometimes following topographic features or other aspects of the underlying geography. Birds also fly with a velocity different from that of the background wind velocity.

In this discussion we have been considering birds as targets and weather as "noise" against which the bird targets should be recognized. However, we can also look at this from the opposite point of view. Most computer programs running at NEXRAD radar sites will be concerned with the recognition of weather targets and will consider targets other than weather to be "noise." In our analysis of bird targets on these radars, we have concluded that many of the methods for automatically recognizing weather features on NEXRAD radars will often be troubled and will sometimes report incorrect results, due to bird targets. In Figure 8 we see an image taken with the research radar operated by the Illinois State Water Survey and the University of Chicago. This image is complex, with a mesoscale structure including precipitation echos to the southeast and a small frontal system extending diagonally across the center of the display toward the northwest. The region of interest in this image is on a

line extending from about 045° to about 235°. Note that there is considerable shear along this line. Targets close to the radar, and therefore at low altitudes, are moving away; whereas targets farther out (at high altitudes) are approaching. The opposite is true along the 045° line from the center.

Large differences in wind at different altitudes constitute wind shear. In some situations, such shear can be hazardous to aircraft; however, in this particular situation the "wind shear" is actually "bird shear," due to birds flying in different directions at different altitudes. Thus, we see that bird targets can generate misleading results from weather recognition schemes that do not take the nature of the targets into account.

III. Real Time Recognition of Birds on NEXRAD

The Illinois Natural History Survey is presently engaged in writing computerized procedures, called algorithms, to allow NEXRAD radars to automatically discriminate birds from other targets and to estimate their densities. Presently, a concentrated effort is being made to provide recognition of migrating passerines and waterfowl and of the larger local movements of waterfowl. In future years, this will be expanded to include coasting and roosting movements of gulls and movements of starlings and blackbirds to and from large winter roosts. Unfortunately, NEXRAD radars will be unlikely to detect single flying birds nor to detect birds flying at treetop altitude or lower. Therefore, some classes of bird hazards, such as individual hunting or migrating raptors, will remain undetected and unreported by NEXRAD systems. Nevertheless, warnings of other kinds of bird targets described above should be given in an automatic and timely fashion, with data available about every 15 minutes.

Output from the NEXRAD computers will consist of both printed text messages and images on sophisticated color displays such as those seen in the Figures for this paper. Our present idea is that the NEXRAD radars will report bird hazards with reference to large geographical areas, not pinpoint locations, and to estimate the degree of hazard in different altitude strata over these regions. The U.S. Air Force has the responsibility for communicating future warnings from such summaries to pilots in the air and before takeoff.

IV. Ring Angels on Doppler Weather Radar

Winter roosts of starlings and blackbirds are an important hazard. Large numbers of these birds, up to millions but usually tens or hundreds of thousands, roost together in sheltered areas for extended periods during the winter. In early morning, they take off in massed fashion, with pulses or waves of birds leaving the roost and other pulses following a minute or more later. The clusters present a distinct hazard.

Images taken during a morning in early December in Champaign, Illinois at the Illinois State Water Survey show almost no targets at all before dawn. Operating the radar "on the deck" at minimal elevation, the images show buildings, highways, and hills, but no moving targets except scattered specks. A few minutes later, (Figure 9) we see about 100,000 starlings leaving a roost 10 km north of Willard Airport. Flying in calm conditions, the birds depart almost uniformly in all directions and one can clearly see the waves of departing birds. They are flying at about 50 meters altitude AGL. The birds fly 30 km or more to their feeding areas, returning in smaller, but still hazardous, groups in late afternoon.

One notices that there appear to be fewer moving targets to the South in this "bull's eye" pattern than in the north part. This is because the small cities of Champaign and Urbana have tall targets, namely buildings, and the average speed of a small target such as a bird and a large target such as a building is nearly zero.

These results are encouraging because they demonstrate the potential of NEXRAD Doppler weather radars to observe clear bird hazards even at very low altitude.

Figure 1. NEXRAD (Next Generation Weather Radar) logo.

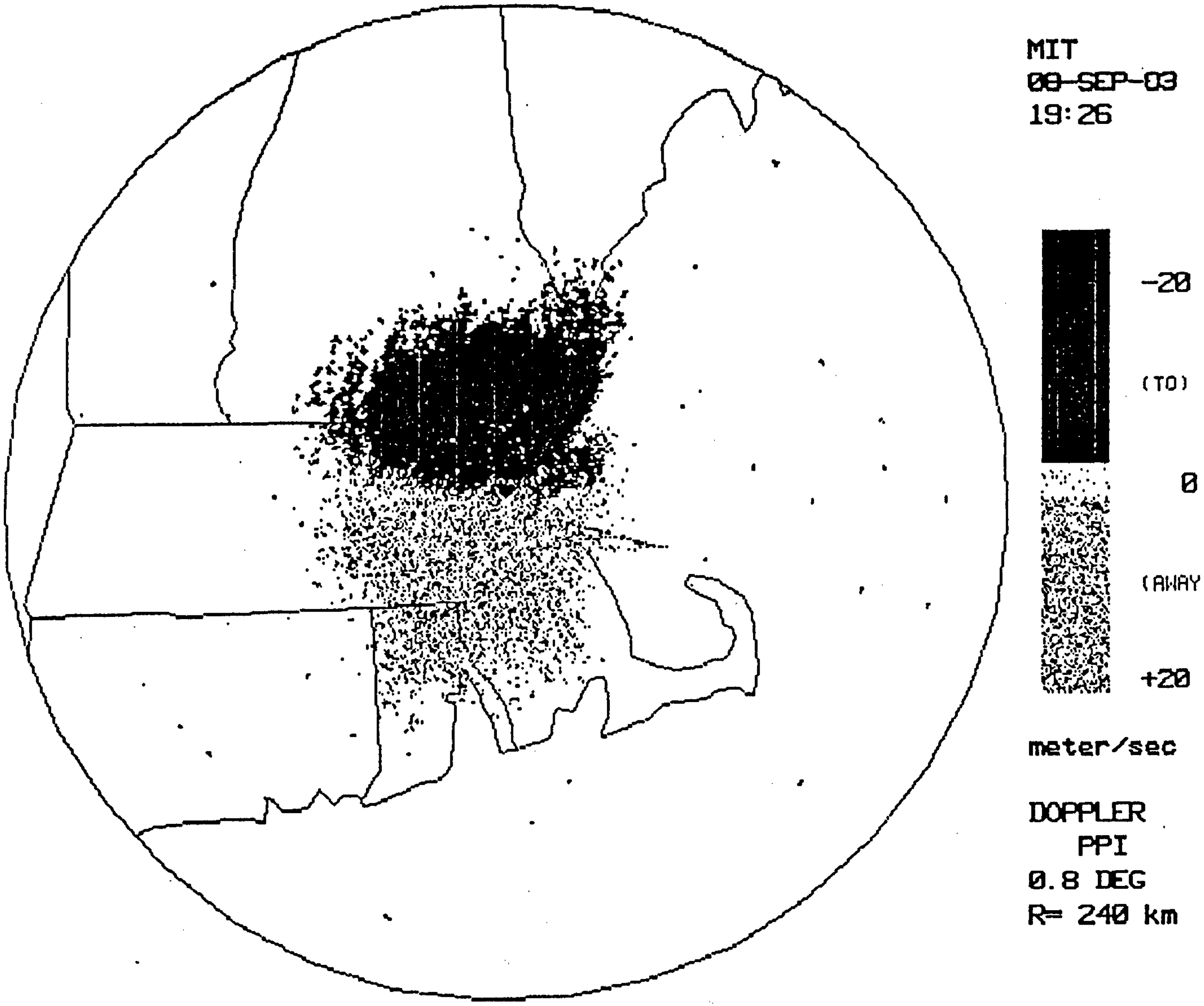

Figure 2. PPI (Plan Position Indicator) of migrating birds flying south over New England. The legend on the right in each of the PPI displays in this paper provides information in the following format:
Radar location (MIT), Date (8-Sep-83), Time (19:26), a bar graph indicating the color codes, the units of data recorded (meter/second), the type of data (Doppler), the type of display (PPI), the elevation angle of the radar beam (0 `), and the range from the center to the perimeter of the display (240 km).

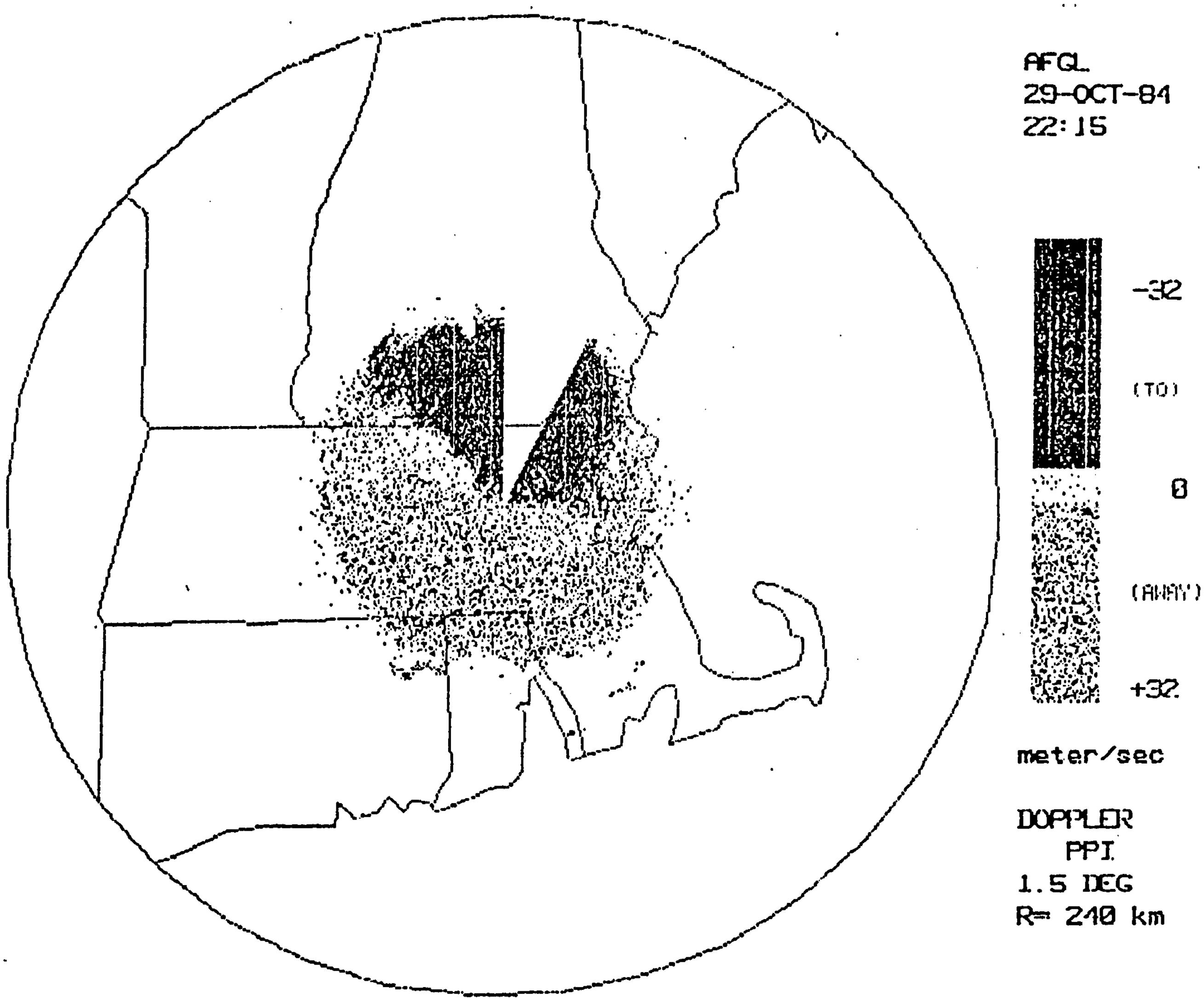

Figure 3. PPI of birds flying south over New England (see text for details). Data were not collected between 0° and 30° (N-NNE).

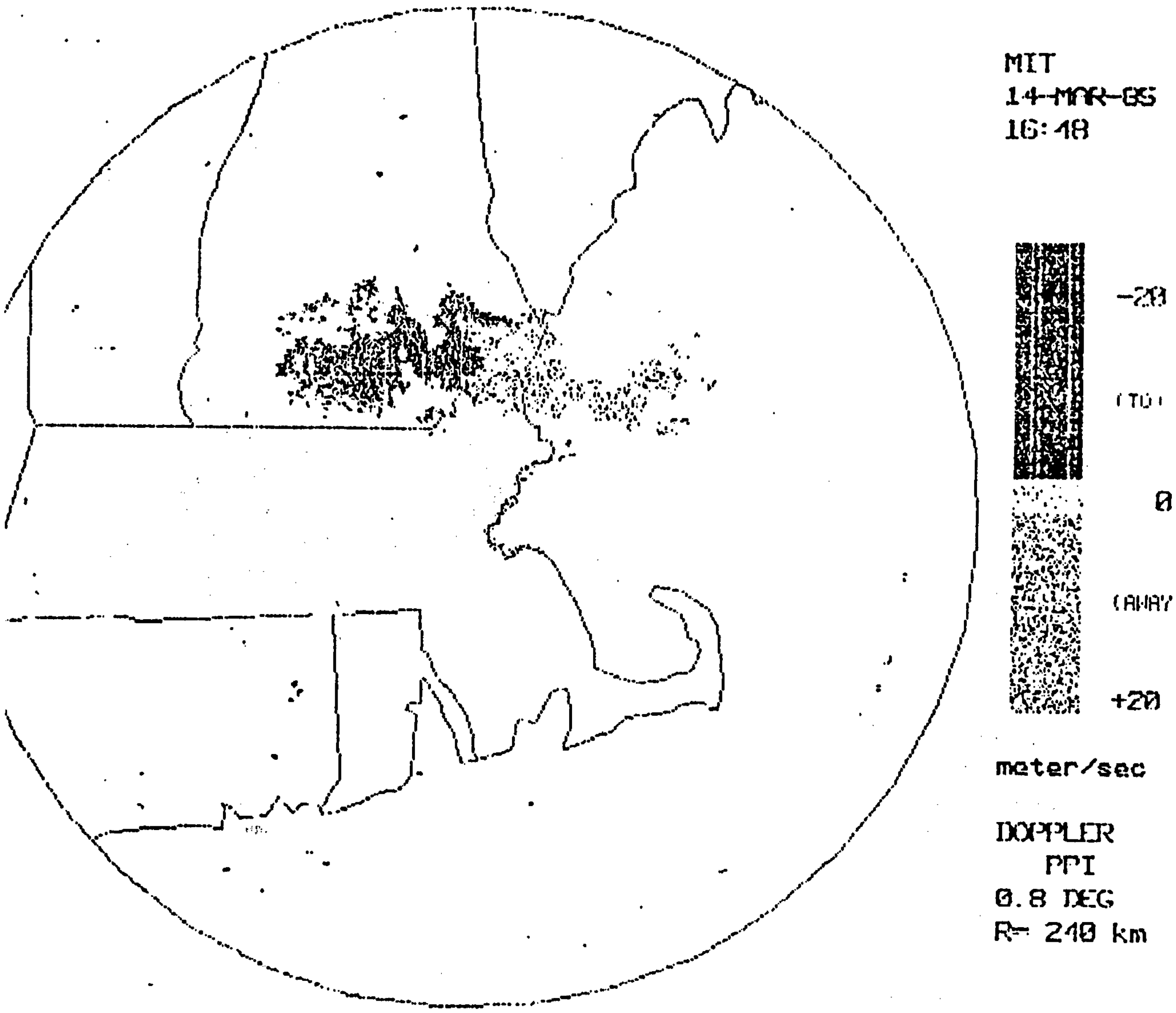

Figure 4. PPI of post-cold-front clouds passing 45 kilometers north of the radar site (see text for details).

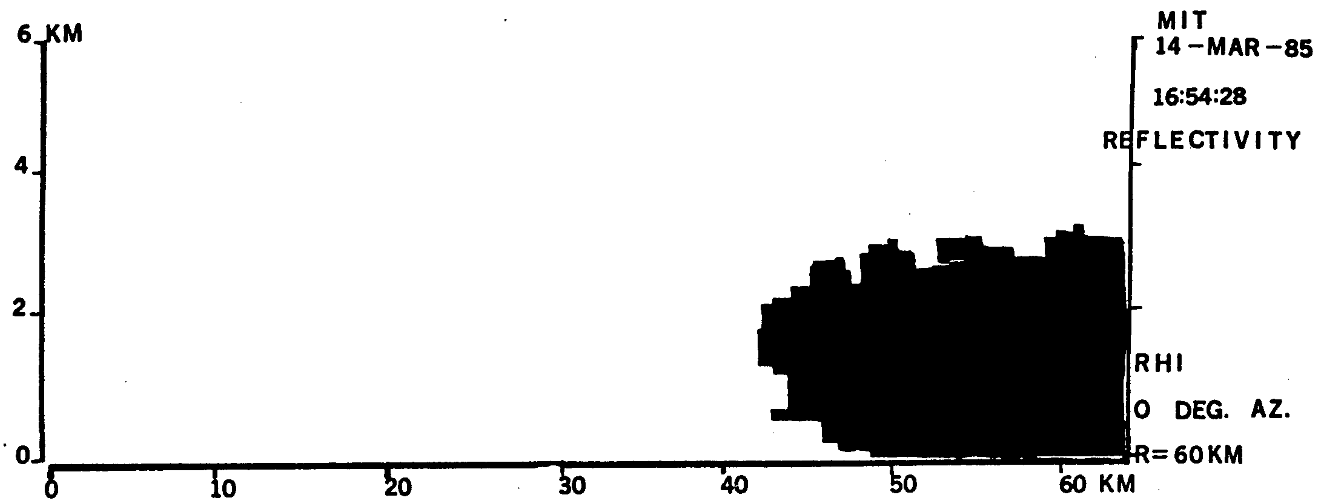

Figure 5. RHI (range height indicator). This display is a vertical cross section of the data shown in Figure 4 going towards the north. The post-cold-front clouds are seen starting at a range of 45 kilometers and extending from ground level to an altitude of 3 kilometers. Reflectivities ranged from 10 to 25 dBZ. The legend on the right in each of the RHI displays in this paper provides information in the following format:

Radar location (MIT), date (4-Mar-1985), time (16:54), type of data (reflectivity), type of display (RHI), azimuth angle of the radar beam (0°), and total range shown (60 km).

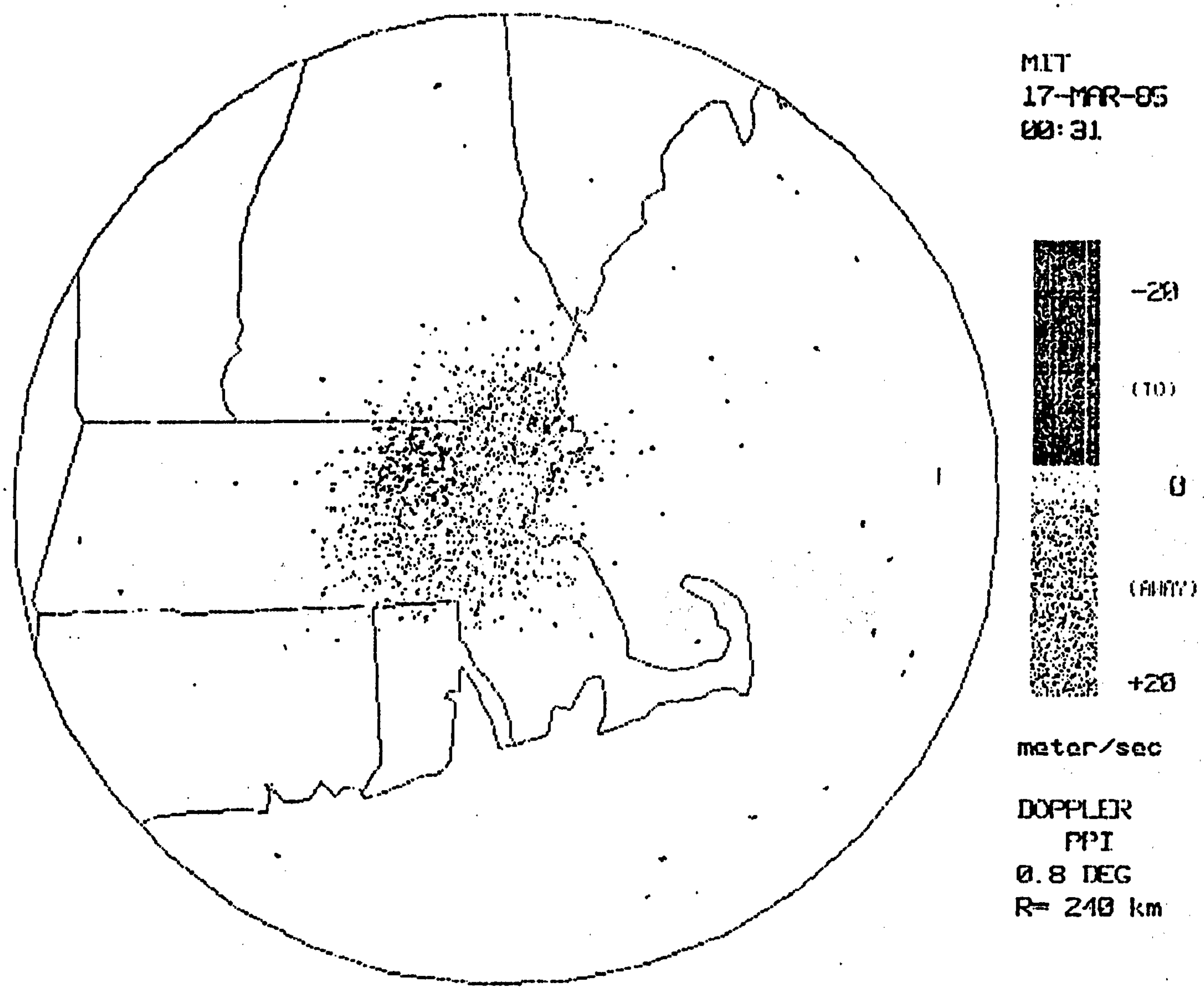

Figure 6. PPI showing characteristically inhomogeneous echos from migrating birds (see text for details).

Figure 7. RHI showing a vertical cross section towards the west of the birds shown in Figure 6. Reflectivities ranged from 10 to 20 dBZ.

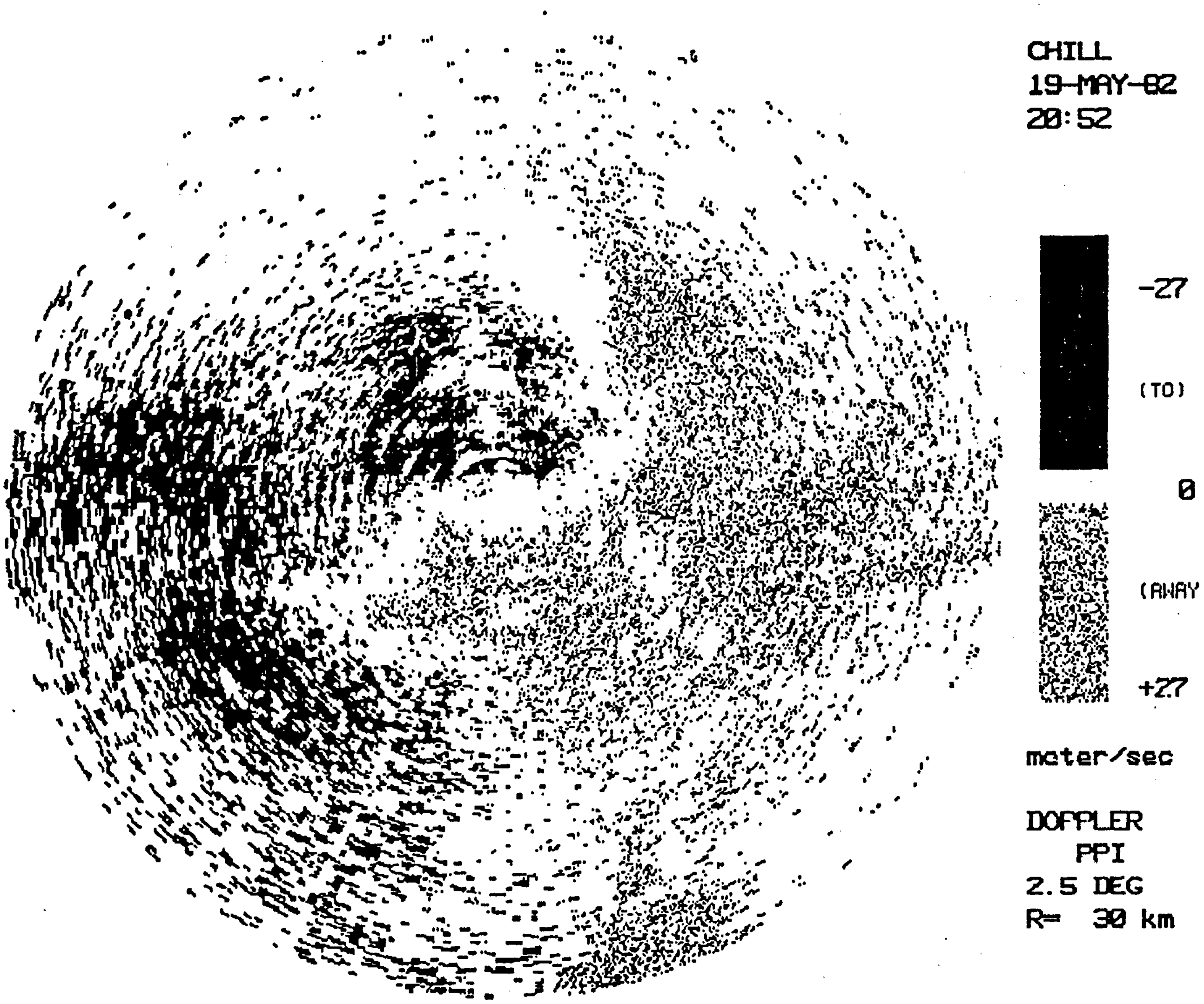

Figure 8. PPI showing "bird shear" (see text for details).

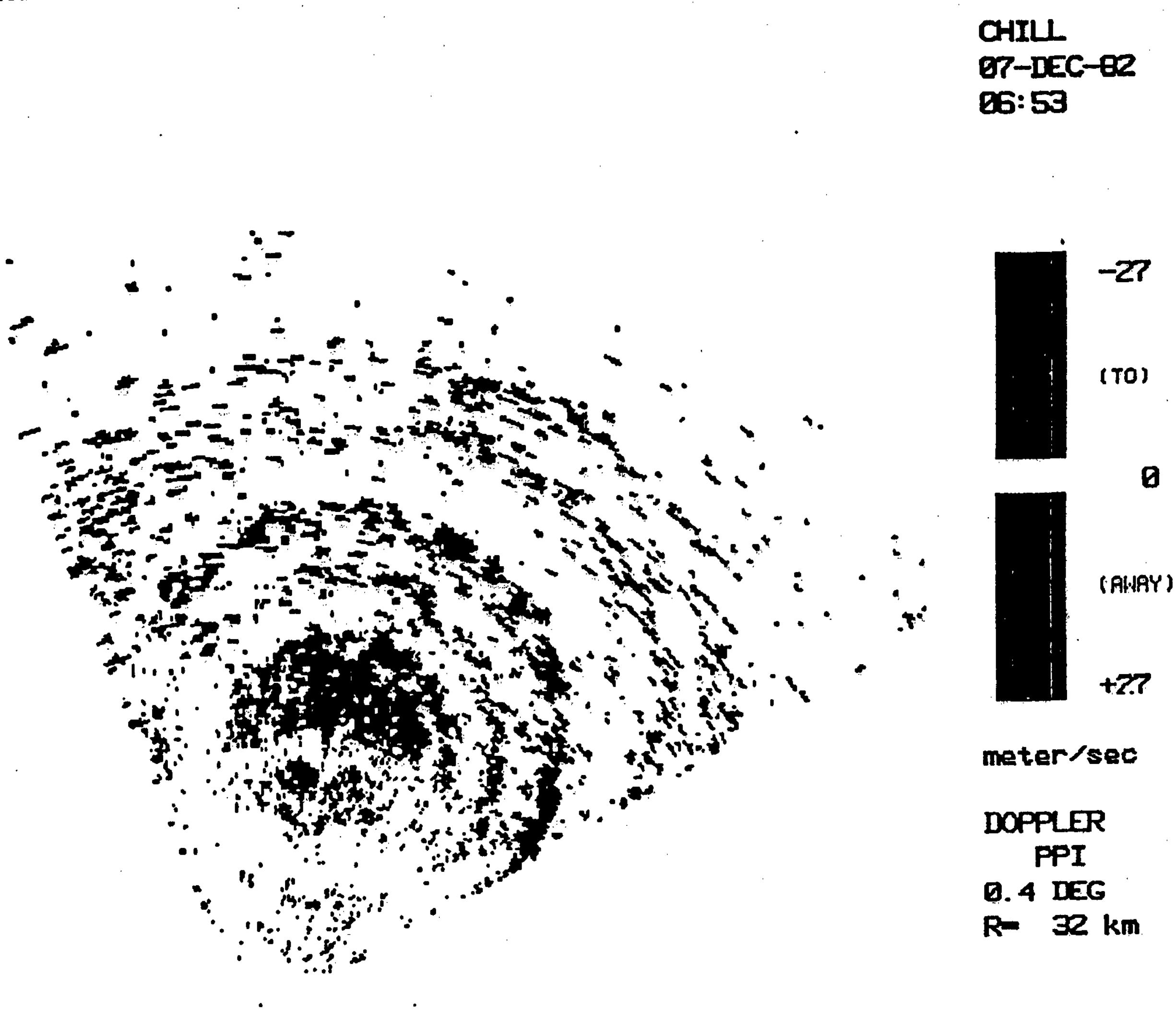

Figure 9. PPI showing approximately 100,000 starlings leaving a roost 10 kilometers north of the CHILL radar in at least 5 discrete waves. These "ring angels" are described more fully in the text.

ADF616058

BSCE 18/ WP 8 REVISED
Copenhagen May 1986

U.S. AIR FORCE BIRD STRIKES
1983-1985

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Abstract

The United States Air Force Bird-Aircraft Strike Hazard (BASH) Team has maintained birdstrike records for the USAF since 1975. Although some data is available from as early as the 1960's, inconsistent reporting procedures and incomplete information limits its use. Not until 1982 have awareness programs and mandatory reporting procedures resulted in consistent birdstrike reporting throughout the Air Force. Finally, we are getting a more accurate picture of the overall impact birds are having on our aircraft. This paper presents 1984 and 1985 USAF birdstrike data and analyzes and compares data from 1983 (BSCE 17), 1984 and 1985.

INTRODUCTION

The Bird-Aircraft Strike Hazard (BASH) Team has maintained United States Air Force bird strike data since 1975. Although some data is available from as early as the 1960's, much of it is sketchy due to inconsistent reporting procedures and incomplete information. These early data are useful for supporting research and development efforts, but are not complete enough to establish trend information for directing BASH reduction efforts. Mandatory reporting procedures and improved BASH awareness programs have resulted in consistent bird strike reporting since 1982 throughout the Air Force.

The BASH Team has directed an intense awareness program to emphasize the importance of bird strike reporting. The 1985 program included a pilot-oriented BASH film, "Dangerous Encounter," an Air Force-wide workshop for BASH reduction program managers, and numerous safety journal publications. The current bird strike awareness program stresses pilot response, pilot identification of hazards, a model BASH Plan, BASH reduction methods from trend information, and research and development of bird resistant aircraft parts.

Mandatory bird strike reporting reinforced with a strong awareness program is providing us a good strike data base and giving us a more accurate picture of the overall impact birds are having on our aircraft.

In 1984 the Air Force reported over 2300 strikes, which was consistent with the 1983 report (BSCE 17). Increased emphasis on strike reporting elevated the 1985 strike report to 2700. Although increased awareness has increased reported strikes, BASH reduction efforts have realized a dramatic decrease in strikes at individual bases. Unfortunately, at this time, critical information is not available in order to perform proper statistical analysis for all reported Air Force bird strikes. Air Force bird strike trends and a summary of the data gathered are given below.

AIRCRAFT INVOLVED IN BIRD STRIKES

Aircraft mission plays a major role in which planes take the most bird strikes. Aircraft which fly high speed, low-level will be much more susceptible than those which spend more time aloft. Additionally, aircraft size, configuration, type of engine and geographic location play a role in aircraft susceptibility to strikes.

Figure 1 shows that fighter aircraft led the list in most bird strikes. This fact is not surprising but can be misleading. The number of aircraft involved, hours flown and emphasis on low-level flying make our fighters most susceptible to bird strikes, yet other aircraft such as the B-52 actually have higher strike rates per flying hour. Overall, the Air Force averages 76.1 strikes per 100,000 flying hours.

IMPACT LOCATIONS

Any part of an aircraft can be, and has been, struck by birds (Figure 2). It appears that the probability of a strike on any portion of an aircraft is directly related to the surface area exposed to the windstream. Because strikes appear to be randomly distributed on aircraft, a few inches in either direction may spell the difference in a glancing blow with no damage and the loss of an engine or canopy penetration. It is of utmost importance that non-damaging strikes be reported along with those which cause damage due to this fact.

Engine strikes top the list of points of impact, partly due to their relative cross sectional area, but also because strikes to this area are generally most damaging and are thus more thoroughly reported.

Reported canopy strikes have increased over the past couple of years. However, penetrations have decreased due to the retrofitting of impact-resistant canopies/windscreens developed in part by the Wright Aeronautical Laboratory, Wright-Patterson AFB, Ohio. We anticipate decreased damages in the future with the development of new composite skin structures and improved engine designs.

BIRD STRIKES BY PHASE OF FLIGHT

Assuming that many of the bird strikes in the "unknown location" category occur on airfields, over 50% of Air Force bird strikes occurred in the airdrome environment (Figure 3). This proportion is due to the fact that a great deal of time is spent in this environment. Also, high aircraft density, low altitude and greater vulnerability to strikes during takeoff and landing contribute to this statistic. Fortunately, it is in this area where we have the most control to reduce bird hazards. Airfield habitat manipulation is critical to bird strike reduction and maximum effort should be taken to make the airfield as unattractive to birds as possible. Additionally, every airfield should have frightening equipment on hand, particularly bioacoustics and pyrotechnics, to disperse flocks of birds as they occur on the field. Operational changes such as raising pattern altitude, changing pattern direction or ground tracks, flying during least hazardous periods, etc., should also be considered.

A large number of bird strikes also occurred on our low-level routes. With the increasing emphasis on high-speed, low-level flying, this is to be expected, but control in this environment is much more difficult to achieve. We can fly at times of the day or season when birds are less prevalent and should avoid known concentration areas of birds. The computerized Bird Avoidance Model (BAM) is helping to make our low-level routes safer by allowing pilots and schedulers to select routes with lesser bird strike risks (Kull 1984).

Figure 4 shows that over 97% of our bird strikes occur below 3000 feet AGL, with the majority occurring in the airdrome and on low-level routes. Since bird strikes increase significantly as altitude decreases, the importance of remaining as high as possible in the pattern and on low-level routes is clear when the mission permits.

TIMES WHEN BIRD STRIKES OCCUR

The Air Force does most of its flying during the day; so naturally, most of our bird strikes occur then. Figure 5 shows that over 70% of our strikes occurred during daylight hours. Birds are most easily seen and avoided during the day and pilots must be aware of measures they can take to reduce bird strikes, such as remaining on the lookout for potential bird hazards, or performing appropriate bird avoidance maneuvers (DeFusco and Turner 1986).

Many birds are most active at dawn and dusk as they fly to and from feeding or roosting areas. Strike numbers are low at this time in large part because little flying is done during these hours. However, a disproportionately large number of strikes occur here per flying hour and extreme caution must be exercised during these times.

Many strikes occur at night during migration periods. Most waterfowl and passerines (perching birds) migrate at night, thus, night flying in spring and fall can be particularly hazardous. October is traditionally our most hazardous month for bird strikes at any time of the day in the U.S. (Figure 6). Different bird movement patterns make mid-summer most hazardous for U.S. Air Force aircraft in Europe.

TYPES OF BIRDS STRUCK

In order to make more meaningful recommendations for bird control, the BASH Team makes every effort to identify the species of birds involved in collisions with aircraft. If local identification is not possible, base safety officers should send feathers to the team for microscopic analysis and positive identification. Increased emphasis on post-strike feather identification has given us a much better idea of which birds to concentrate control efforts on to reduce the hazard. Figure 7 lists the types of birds most commonly involved in collisions with aircraft worldwide. Gulls and raptors (birds of prey) lead the list, with most gulls hit in the airdrome and hawks and vultures on our low-level routes. Gulls can be most effectively controlled by proper habitat management including proper landfill operations, combined with an active frightening program using bioacoustics and pyrotechnics at the airfield. Avoiding raptor strikes is much more difficult and requires operational changes such as flying at times of the day when raptors are not commonly aloft, or avoiding ideal terrain for soaring raptors to utilize. The large number of dove strikes is of concern; most of these strikes were due to improper habitat management at a few bases, such as planting of seed-producing plants near the airfield for agriculture or erosion control.

The importance of positively identifying birds which are involved in collisions with aircraft cannot be overemphasized, because only then can realistic reduction measures be taken. The BASH Team makes recommendations based on species present and conditions at each installation and training area.

CONCLUSIONS

In the past few years, the BASH Team has gained a much better picture of the impact birds are having on our aircraft. Trends such as those presented in this paper allow us to more realistically attack the problem and develop applicable solutions both on a wide-scale and on an individual basis. Collection of complete accurate data allow us to develop these management strategies for future BASH reduction programs wherever we fly. Ultimately, we can make the business of flying a safer one for our aviators.

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Kull, R.C. 1984. Bird Avoidance for Military Low-Level Operations in the United States. Proc. Bird Strike Committee Europe Meetings 17:342-349.

FIGURE 1

BIRD STRIKES BY AIRCRAFT TYPE

1983-1985

Fighter	38%
Cargo	28.2%
Trainer	20.3%
Bomber	8.2%
Other	5.3%

FIGURE 2

BIRD STRIKES BY IMPACT POINT

1983-1985

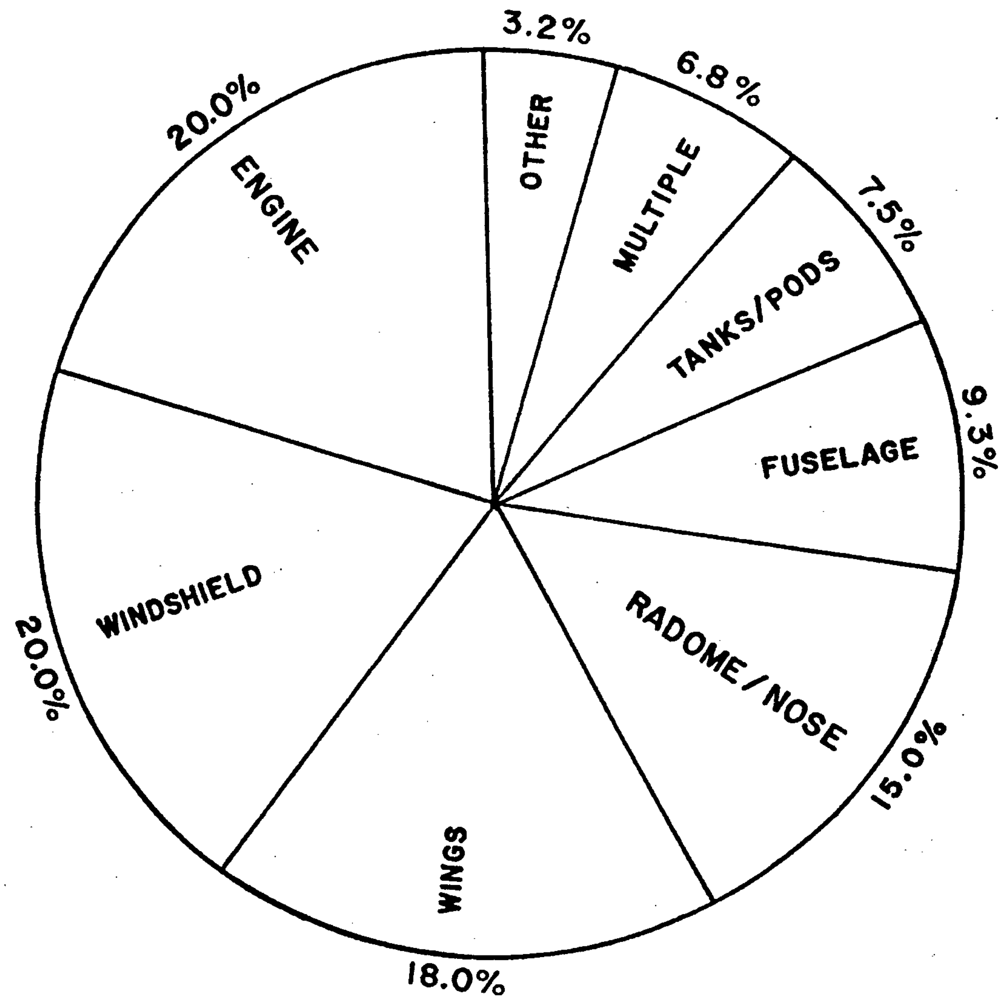


FIGURE 3

BIRD STRIKES BY PHASE OF FLIGHT

1983-1985

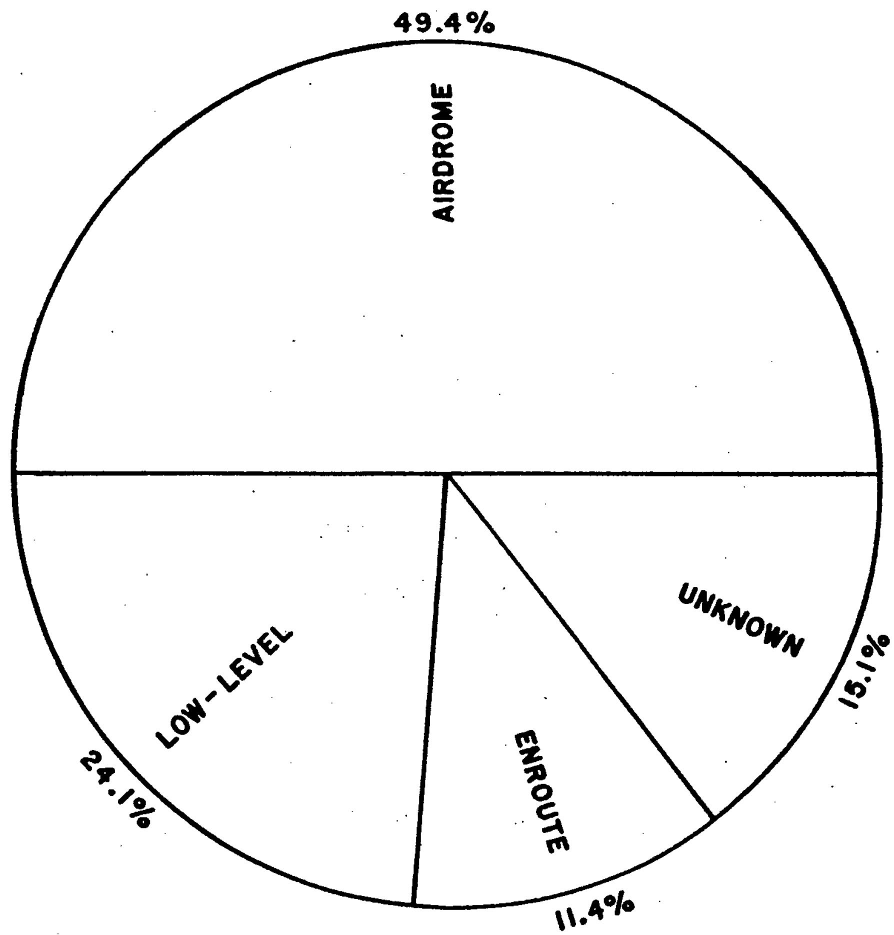


FIGURE 4

BIRD STRIKES BY ALTITUDE

1983-1985

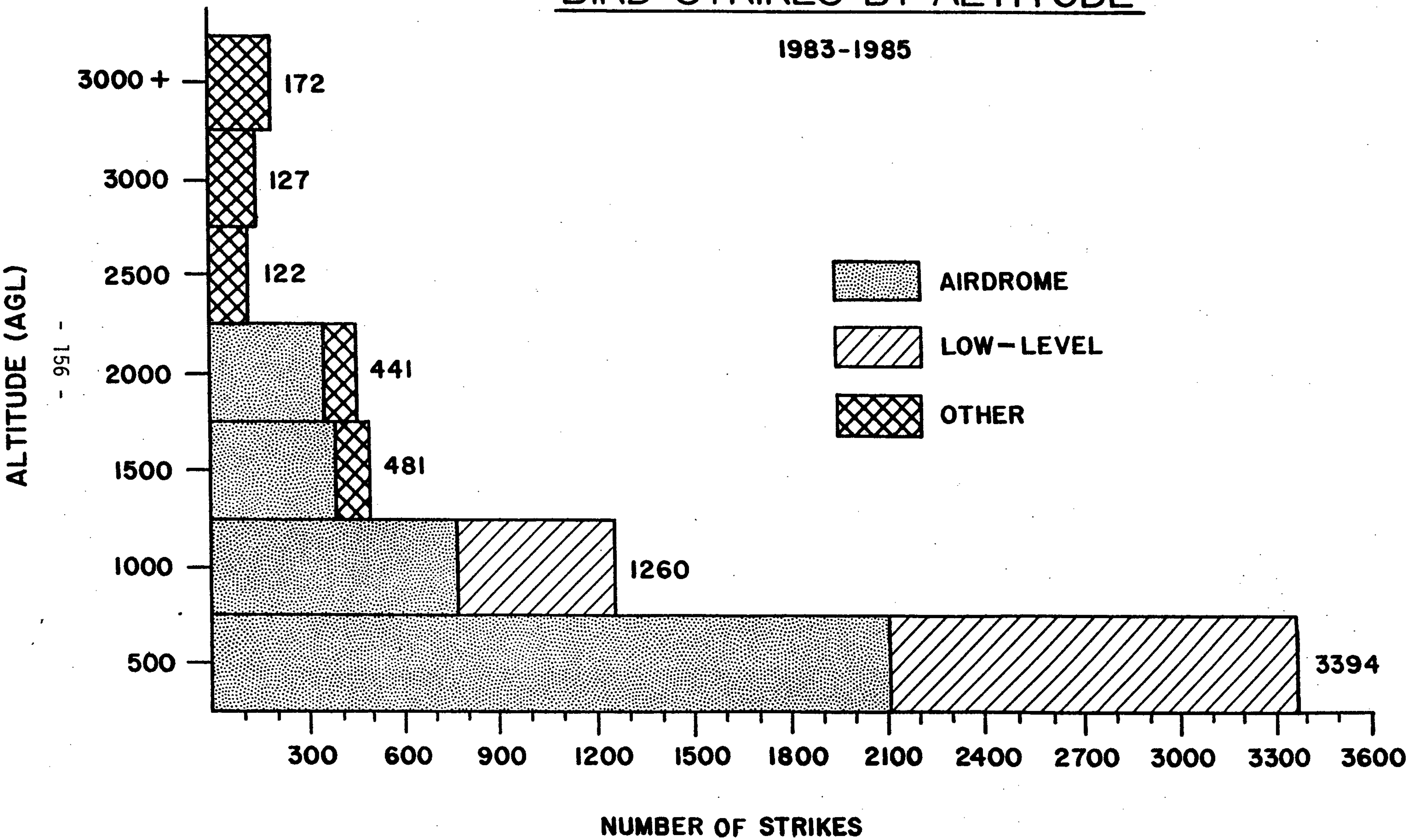


FIGURE 5

BIRD STRIKES BY TIME OF DAY

1983-1985

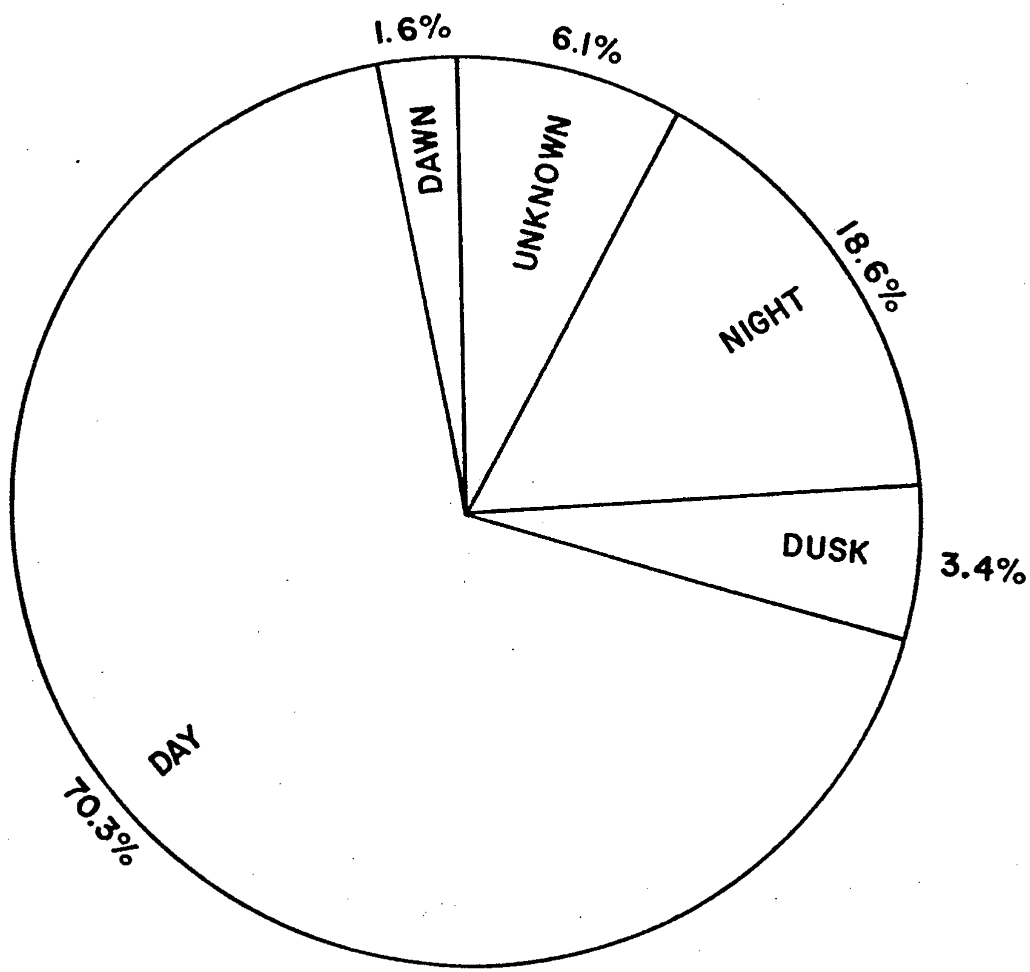


FIGURE 6

BIRD STRIKES BY MONTH

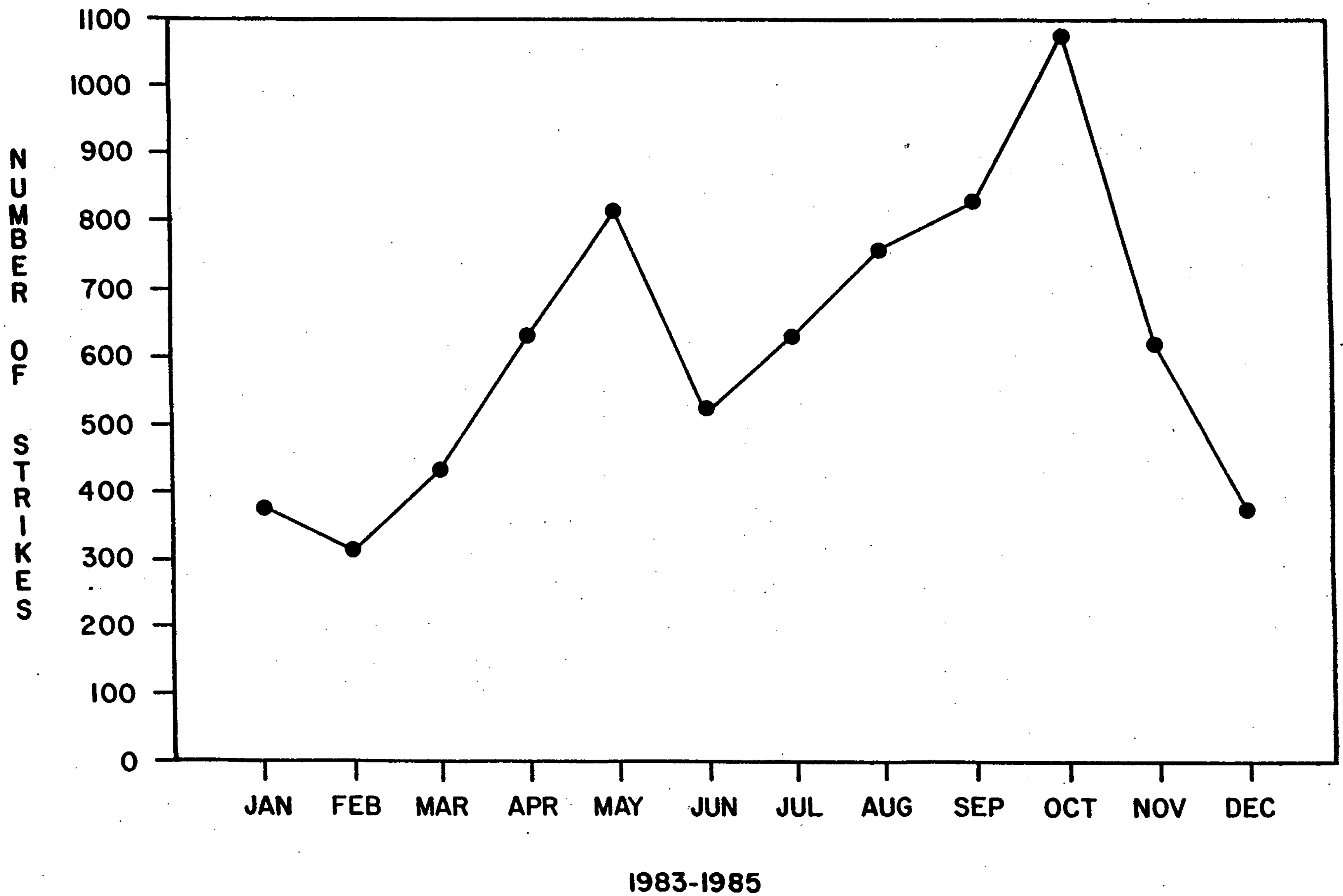


FIGURE 7

BIRD TYPES IDENTIFIED
1983-1985

Gull	364	Horned Lark	82
Hawk	344	Blackbird	79
Vulture	160	Meadowlark	74
Dove	148	Pigeon	56
Duck	126	Egret	44
Starling	82	Shorebird	42

ADF616059

BSCE 18/ WP 14 (REVISED)
Copenhagen, May 1986

HELICOPTER BIRD STRIKE RESISTANCE

by

Mr A. BREMOND - Airworthiness Office
AEROSPATIALE - Helicopter Division

Abstract

The hazard created by bird encounters for helicopter occupants does not account for a large percentage of serious accidents. For example no fatal accident due to a bird strike has been recorded, to date, on the Aerospatiale fleet.

However, some cases of cockpit penetration and of engine ingestion have indeed occured. Furthermore the rotors, the sensible and vital part of the helicopter, must be proofed against bird strike effects.

The particularities of helicopter operation, as compared to its fixed-wing brothers, are essentially :

- usage of unprepared areas for take-off and landings
- necessity to provide for large transparent areas for pilot visibility
- low speed - low altitude operations
- no pressurization

The helicopter windscreens are tested to show compliance with the relevant BCAR regulations, and in some cases it has been necessary to improve the initial design.

The air intakes must be consistent with engine regulations regarding bird ingestion or protection. Tests are carried out to develop suitable protection and show compliance with engine regulations.

Rotor blades are not subjected to any regulation, but Aerospatiale has assessed, through similar testing and strain measurements, that bird strikes have only minor effects on blade integrity.

A movie is presended to illustrate typical tests conducted on these three sensitive areas of the helicopter.

1 - GENERAL

Helicopter, like fixed wing aircraft sometimes meet birds in flight and therefore are at risk to sustain some damage, possibly endangering flight safety. So, like airplanes this type of encounter is taken into account when designing exposed areas of helicopters.

1.1 - In-Service experience

First if we look at the accident history of Aerospatiale helicopter fleet, bird impacts are not an important cause of accidents, and in particular no fatality has been recorded to date for this reason (cables, for example, are by far a much greater jeopardy for helicopters). The reasons may be attributed to specific features of helicopters and their type of operations.

1.2 - Helicopter operation particularities

As compared to fixed wing operations, those of helicopters feature positive and negatives aspects :

- operations from and to unprepared areas where specific action against bird presence cannot be contemplated

- large transparent surfaces needed for crew visibility in specific aerial work missions very close to ground

- but low speeds generally used at low altitudes, and for current models no pressurization of the cockpit and cabin.

It is possible that some degree of protection owing to the main rotor in forward flight, and specific devices avoiding engine ingestions may help minimize birds hazards.

1.3 - Regulations

But the risk must not be ignored, and to start dealing with it some regulatory requirements must be met to obtain type certification.

- For airframe, only UK regulations (BCAR G-4-1-10) require specific resistance of rotorcraft to bird impacts.

- For engines, US (FAR 33-77) UK (BCAR C-4-6 parag.19) and European (JAR E) regulationsconsistently require a specific engine response. Compliance with these requirements could be obtained by engine design by itself but the present practice is to provide protection through engine intakes design.

Although no regulation at all applies to rotor resistance to bird impacts, Aerospatiale has carried out some tests to make sure that no problems could arise with this essentially vital part of the helicopter.

1.4 - Helicopter exposed areas

So we shall deal successively with these three groups of exposed areas of the helicopter: wind screens, engine intakes, rotor blades.

1.5 - Test installations

Full scale testing being generally necessary to assess structural resistance to object impacts, Aerospatiale makes use of specific installations named "bird guns" which have been built at two different Government Tests Laboratories in France :

- Saclay (near Paris) Powerplant Test Centre (CEPr) for engines intakes

- Toulouse Aeronautical Test Centre (CEAT) for windscreens and rotor blades.

Both installations allow full strain instrumentation recording and high speed movie cameras.

2 - WINDSCREENS BIRD IMPACT RESISTANCE

2.1 - Windscreen bird strike tests

Bird strike tests are carried out to show compliance with BCAR G-4-1-10. The impact must be demonstrated at maximum forward speed. The bird size to be tested is dependent upon the helicopter maximum gross weight (up to 4 lbs for large helicopters). The specification retained by Aerospatiale is that the bird must not penetrate the cockpit. Permanent deformations are acceptable if they do not affect airframe structural integrity.

2.2 - Windscreen impact research

Beyond strict compliance with existing regulations, research and development actions are in progress to optimize, as regard to cost and weight, material and attachments of windscreens, and to develop analytical methods to predict impact behaviour. Most promising are multi-layer panels with energy absorption capabilities, but research is only at an early stage and no conclusive results have been obtained so far.

3 - ENGINES BIRD INGESTION

3.1 - Engine regulations

The above mentioned regulations stipulate that in case of engine bird ingestion:

- no hazardous conditions are created by a 4 lb-bird impact at max speed. (in fact, no risk of engine uncontained breakdown)

- the power loss, after small and medium birds ingestions at V climb, is limited to 25%.

3.2 - General remarks

The philosophy at Aerospatiale is to prevent bird ingestion, protection of the engines being necessary for several other reasons like F.O.D., compressor erosion (sand or dust), snow-water-ice ingestion.

3.3 - Air intake protective design

So, the design of air intakes must take these effects into account and appropriate arrangements are used to this effect :

- static air intakes (SA 365C, AS 350)

- front or lateral dynamic air intakes (AS 332, SA 365N, AS 355) with protective grids

- optional protective devices : "snow-shields", sand filters, multi-purpose air intakes.

3.4 - Air intakes design objectives

For dynamic air- intakes, most often utilized because of better performance, the design objectives are to retain small and medium birds with the grid and if possible to retain also large birds. If not, it is necessay to demonstrate large bird ingestion into running engine.

3.5 - Bird strike tests

Bird strike tests are carried out on actual complete structure(grid, stiffness, attachments, stubframe, forward air duct) each component participating, through its deflection, to bird retention. The bird retention up to 4 lbs, is in fact obtained by controlled deformation of all the components.

4 - ROTOR BLADES BIRD IMPACTS

4.1 - General remarks

Bird impact tests on rotor blade sections have been carried out, in the absence of specific regulation, but presented to Certification Authorities during the type certification process.

The objectives were to evaluate direct impact damage on blade section, to analyze possible detrimental effect on rotor transmission systems, and to validate theoretical analysis capable of transferring the results to other types of blades and aircraft.

4.2 - Test program

The test program objectives were to checkbird impact effect on three typical blade stations. These stations differ because of angle of attack, centrifugal tension and resultant speed variation with blade radius.
The test conditions are intended to simulate VNE plus local velocity due to rotor rotation, actual angle of attack and centrifugal tension, and to test a 4 lb-bird impact.
The validation of mathematical analysis model, to be used for determining the effects on transmission and for application to other designs, necessitates to carefully identify the blade section vibratory modes, and to record a time-history of stress levels.
This is done by means of a comprehensive strain gauge equipment and measurement circuits.

4.3 - Bird strike test results

The bird strike tests as described above, have given very satisfactory results on AS 332 blade sections. Local damage is limited to minor dents showing neither separation nor degradation requiring blade shop repair.
The effect on transmission system is not significant as compared to normal service loads.
The mathematical analysis model has been validated and is now available for other types.

5 - CONCLUSIONS

Bird strike hazard, although accounting for a small percentage of all accidents, exists for helicopters, as it does for airplanes.
It is consequently necessary to minimize such hazards and windscreens, air intakes and rotor blades will have to be specifically designed and tested to withstand bird impacts.
Some changes to the initial design may have been necessary to comply with existing regulations, but the final certified definition amply meets, and exceeds in some cases, the applicable requirements.

COPENHAGEN MAY 86

HELICOPTER BIRD STRIKE RESISTANCE

BY ALAIN BREMOND

AIRWORTHINESS OFFICE

AEROSPATIALE HELICOPTER DIVISION

HELICOPTER BIRD STRIKE RESISTANCE

1. GENERAL

1.1. IN SERVICE EXPERIENCE

FOR AEROSPATIALE HELICOPTER FLEET,TOTALLING TO DATE 18000000 FLIGHT HOURS,

- NO FATAL ACCIDENT
- 4 NON FATAL OCCURRENCES (INCLUDING ONE ACCIDENT FOLLOWING AN AVOIDING MANOEUVER)

HELICOPTER BIRD STRIKE RESISTANCE

1. GENERAL

1.2. HELICOPTER OPERATION PARTICULARITIES

- UNPREPARED AREAS FOR TAKE-OFF & LANDING
- LARGE TRANSPARENT SURFACES NECESSARY FOR CREW VISIBILITY
- LOW SPEED, LOW ALTITUDE FLIGHTS
- NO PRESSURIZATION

HELICOPTER BIRD STRIKE RESISTANCE

1. GENERAL

1.3. REGULATIONS

- AIRFRAME : BCAR G 4.1.10
  NO FAR REQUIREMENT
- ENGINES : FAR 33.77
  BCAR C 4-6 PARA. 19
  JAR E

HELICOPTER BIRD STRIKE RESISTANCE

1. GENERAL

1.4. HELICOPTER EXPOSED AREAS

- WINDSCREENS
- ENGINES AIR INTAKES
- ROTOR BLADES

HELICOPTER BIRD STRIKE RESISTANCE

1. GENERAL

1.5. TEST INSTALLATIONS

- «BIRD GUN» WITH SIZE AND SPEED VARIATION
- HIGH SPEED MOVIE CAMERAS
- POSSIBILITY OF STRAIN MEASUREMENTS AND RECORDINGS

HELICOPTER BIRD STRIKE RESISTANCE

2. WINDSCREENS

2.1. WINDSCREEN BIRD STRIKE TESTS

- AIMED AT SHOWING COMPLIANCE WITH BCAR G 4.1.10
- AIRSPEED SIMULATED : MAX FORWARD SPEED
- BIRD SIZE : AS PER REGULATIONS (2 TO 4 LBS)
- SPECIFICATION : NO PENETRATION INTO COCKPIT

HELICOPTER BIRD STRIKE RESISTANCE

2. WINDSCREENS

2.2. WINDSCREEN IMPACT RESEARCH

TESTS IN PROGRESS WITH OBJECTIVES :

- VALIDATION OF MATHEMATICAL IMPACT MODEL
- OPTIMISATION OF WINDSCREEN MATERIAL (MULTI-LAYER PANELS)
- EFFECT OF BOUNDARY ATTACHMENT

HELICOPTER BIRD STRIKE RESISTANCE

3. ENGINES

3.1. ENGINES REGULATIONS

- FAR 33.77, JARE, BCAR C 4-6 PAR. 19
- NO HAZARDOUS CONDITION AFTER IMPACT OF LARGE BIRD (4 LBS) AT V MAX
- LESS THAN 25 % LOSS OF POWER AFTER SMALL AND MEDIUM BIRDS IMPACTS AT V CLIMB

HELICOPTER BIRD STRIKE RESISTANCE

3. ENGINES

3.2. GENERAL REMARKS

AIR INTAKE DESIGN MUST PROVIDE PROTECTION AGAINST

- F.O.D.
- BIRDS
- COMPRESSOR EROSION (SAND, DUST)
- SNOW, WATER OR ICE INGESTION

3. ENGINES

3.3. AIR INTAKE PROTECTIVE DESIGNS

- STATIC INTAKES (SA 365 C, AS 350)
- RAM AIR INTAKES WITH GRIDS (AS 332, SA 365 N, AS 355)
- OPTIONAL PROTECTIONS :
  - SNOW SHIELDS
  - SAND FILTERS
  - MULTI-PURPOSE AIR INTAKES

HELICOPTER BIRD STRIKE RESISTANCE

3. ENGINES

3.4. RAM AIR INTAKES : DESIGN OBJECTIVES

- THE GRID SHALL RETAIN SMALL AND MEDIUM BIRDS
- FOR LARGE BIRDS :
  - THE GRID RETAINS THE BIRD OR
  - COMPLETE DEMONSTRATION OF BIRD INGESTION INTO RUNNING ENGINE

HELICOPTER BIRD STRIKE RESISTANCE

3. ENGINES

3.5. BIRD STRIKE TESTS

- ACTUAL COMPLETE STRUCTURE UNDERGOES TESTING
- DEVELOPMENT TEST MAY LEAD TO GRID MODIFICATION
- BIRD RETENTION OBTAINED BY CONTROLLED DEFORMATION OF GRID, STIFFENERS AND ATTACHMENTS

4. ROTOR BLADES

4.1. GENERAL REMARKS

- NO SPECIFIC REGULATORY REQUIREMENT
- TEST OBJECTIVES :
  - EVALUATION OF DIRECT IMPACT DAMAGE ON ACTUAL BLADE SECTION
  - ANALYSIS OF EFFECT ON TRANSMISSION SYSTEMS
  - VALIDATION OF MATHEMATICAL MODEL

HELICOPTER BIRD STRIKE RESISTANCE

4. ROTOR BLADES

4.2. TEST PROGRAM

- DYNAMIC IDENTIFICATION OF BLADE SECTION *
- BIRD SIZE : 4 LBS
- AIR SPEED : VNE + ROTATIONAL VELOCITY
- 3 BLADE STATIONS (EFFECT OF CENTRIFUGAL TENSION AND ANGLE OF ATTACK)
- STRESS TIME-HISTORY ANALYSIS *

* REQUIRES COMPREHENSIVE STRESS MEASUREMENTS

HELICOPTER BIRD STRIKE RESISTANCE

4. ROTOR BLADES

4.3. BIRD STRIKE TEST RESULTS

- MINOR LOCAL DAMAGE (DENTS)
- NO IMPORTANT DEGRADATION (REQUIRING SHOP REPAIR)
- NO EFFECT ON TRANSMISSION SYSTEM
- MATHEMATICAL MODEL VALIDATED

HELICOPTER BIRD STRIKE RESISTANCE

5. CONCLUSIONS

- HAZARDS DUE TO BIRD IMPACT EXIST FOR HELICOPTERS
- IT IS THUS NECESSARY TO CHECK BEHAVIOUR OF :
  - WINDSCREENS
  - AIR INTAKES
  - ROTOR BLADES
- WITH SOME PRECAUTIONS, APPLICABLE REGULATIONS ARE SATISFIED, AND BEYOND

ADF616060

BSCE 18/WP 16
Copenhagen, May 1986

BELGIAN AIR FORCE

RADAR STATION SEMMERZAKE

B.O.S.S. - BIRD OBSERVATION SYSTEM SEMMERZAKE

FURTHER STEPS AND IMPROVEMENTS

by G. DUPONT
Cdt
Air Traf.Contr.

B.O.S.S.

Bird Observation System SEMMERZAKE

1. At the BSCE-ROMA 84 the BELGIAN Air Force presented for the first time its new project for Bird observation by means of Radar, called BOSS.

2. The radar situated at the Radar Station SEMMERZAKE, is a 3D-Radar and is used for Air Traffic Control. The aim has always been NOT to change the radar configuration, so that the operations necessary for bird observation would never disturb the normal routine work namely Air Traffic Control.
   Therefore, the BOSS is used in an "ON-LINE" configuration, which allows the operator to perform Bird Observation without influencing the ATC-capacity.

3. To explain the observation-procedure which has been accepted, it is necessary to recall the history of the most important steps and improvements since 84.

4. During the spring of 1984 the BOSS-system was developped.
   This computor program is based up on the following principles :
   - during a certain time, the incoming plots are stored in the system file, while remaining visible on the scope. This gives PLOTLINES, a traditional picture in fact of AFTERGLOW which used to appear on the 2D-radar at the time that Bird Observation was performed with a POLAROID-camera.
   - These plots are submitted to well-defined criteria so that only the returns of the primary radar are accepted, this means also that only plots WITHOUT IFF are accepted.
   - The effect of ground clutter is eliminated by a range filter, as well as all plots within a range of 10 NM.
   - On the bottom of the radar display 4 figures are displayed. These are the plots which are counted in the different height layers.
   - These layers were maintained from the start of the project and they are as follows :

0	-	2000'
2000'	-	4500'
4500'	-	8000'
8000'	-	10000'

- These layers can be changed easily by the system programmer, if required by FLIGHT SAFETY COMMAND.

5. During the spring migration 84 the BOSS system was used for the first time in its experimental phase. In those days the calibration was NOT yet performed, which meant that NO BIRD-INTENSITY could be attached to the figures we received; in fact our main target, to determine a bird intensity from 0 till 8 at ANY moment, was NOT yet possible at that time.

6. In order to reach a final solution and for calibration purposes, THREE testing periods were used : spring and fall 84 and spring 85.

7. Step by step following experiments and improvements were undertaken :
   - In the spring period 84 we suffered a serious overload of the computer due to the fact that the whole scope was interrogated, so that the plotfile was saturated very fast, which also endangered our ATC capacity.
     Therefore we devided the scope in FOUR quadrants. The computor interrogating only in one quadrant thus excluding overload of the system.
   - These quadrants were limited in range, as to allow full coverage of BELGIUM.
   - For the observation time of a quadrant 5 MINUTES were maintained for the complete scenario.
   - During 4' 30" a quadrant is interrogated in the defined range.
   - All incoming plots are stored in the system file, counted and displayed continuously at the bottom of the scope.
   - During this period the plots can be tracked, providing the operator with H-A-S (Height - Altitude - Speed).
   - After a certain time plotlines are developped which are in fact the birdtracks.
   - A very serious problem were aircraft WITHOUT IFF.
     Of course easily visible due to the abnormal plot separation in such a case, BUT they were counted !
     To solve this problem : after the second incoming plot, keyboard action makes immediately a real track of the plot, stopping the progress of that plot (becoming track) and ensuring that it is NOT counted anymore.

- After this 4' 30" period, which is in fact the working and build-up phase, the actual observation period starts and takes 30". During these 30", the system automatically replays the 4' 30" recorded picture in 2 seconds, giving a MOVING-DISPLAY.

  This moving display is repeated FIVE times, giving a clear and realistic presentation of that bird movement with a displacement effect.
- Also during these 30" the counted figures at the bottom of the scope remain stable which allows the observer to copy them on his working paper.
- Once these 30" moving display have passed the figure on the bottom of the scope shows ZERO's indicating that the system has started the interrogation of the next quadrant in the same manner.
- The interrogation of the whole scope takes 20 minutes and is permanently possible.

8. To attain our main object, the calibration of the BOSS-system in order to obtain the capability of fixing a bird-intensity from 0 to 8 over our country, the whole of 1984 and spring 85 were needed. The second radar station in Belgium, GLONS, is still equipped with the POLAROID system. During the whole of 84 and spring 85, the observations were performed by both units daily. These observations gave us a large amount of information. Maxima and minima plots counted in these periods were studied and compared during THREE migration periods.
   Taking into account the different patterns of the bird migrations (spring and fall) and the figures observed, the tests gave us satisfaction and the system was calibrated.
   The BOSS system has been certified and after the spring migration 85, accepted by the Belgian Air Force.

PRINCIPLES OF THE PROGRAM

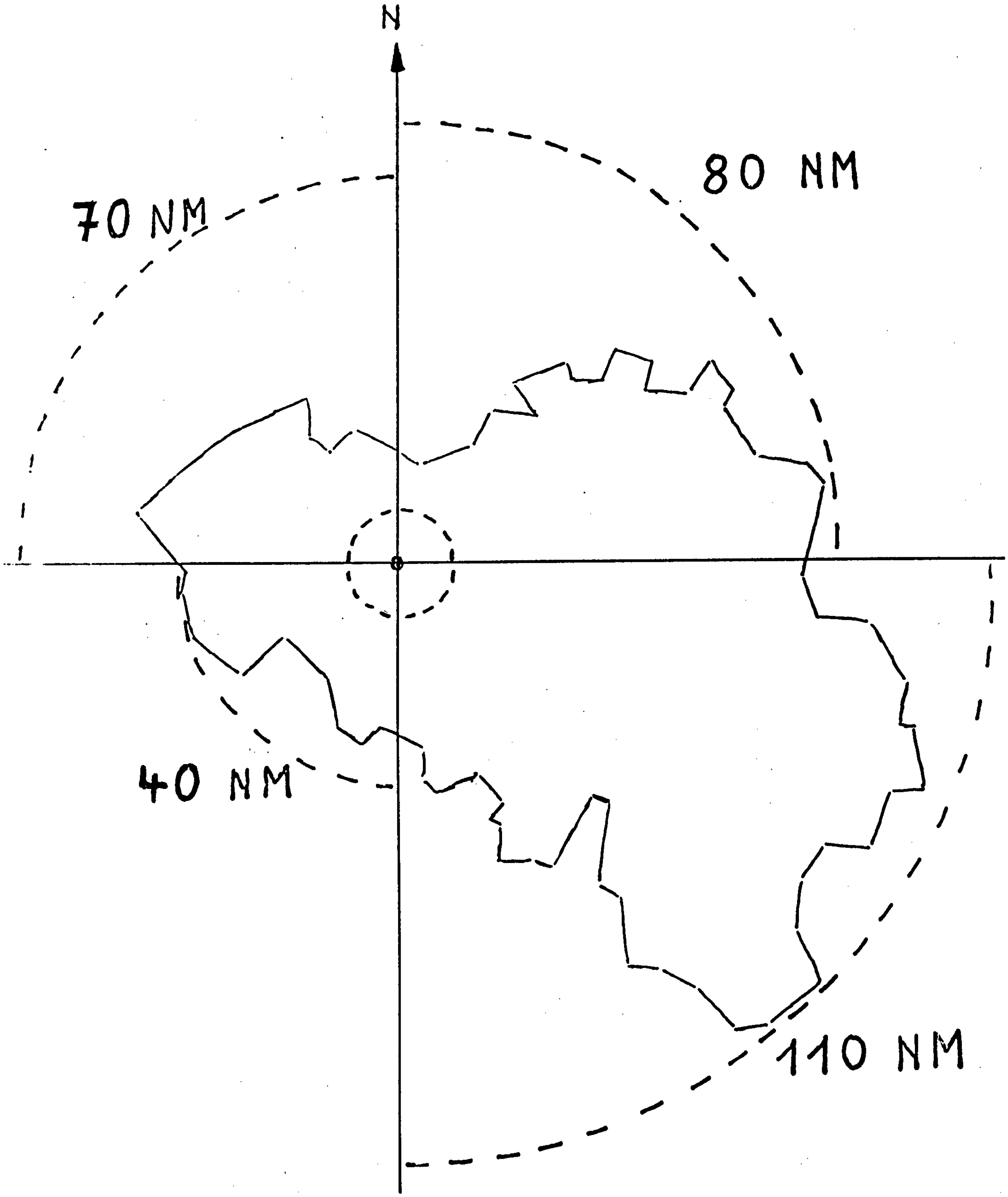
- INCOMING PLOTS ARE STORED
- PLOTS REMAIN VISIBLE → PLOTLINES
- CRITERIA FOR PLOTS : ONLY PRIMARY
- GROUND CLUTTER ELIMINATED (10NM)
- DISPLAY OF COUNTED PLOTS IN HEIGHT LAYERS

START AND IMPROVEMENTS

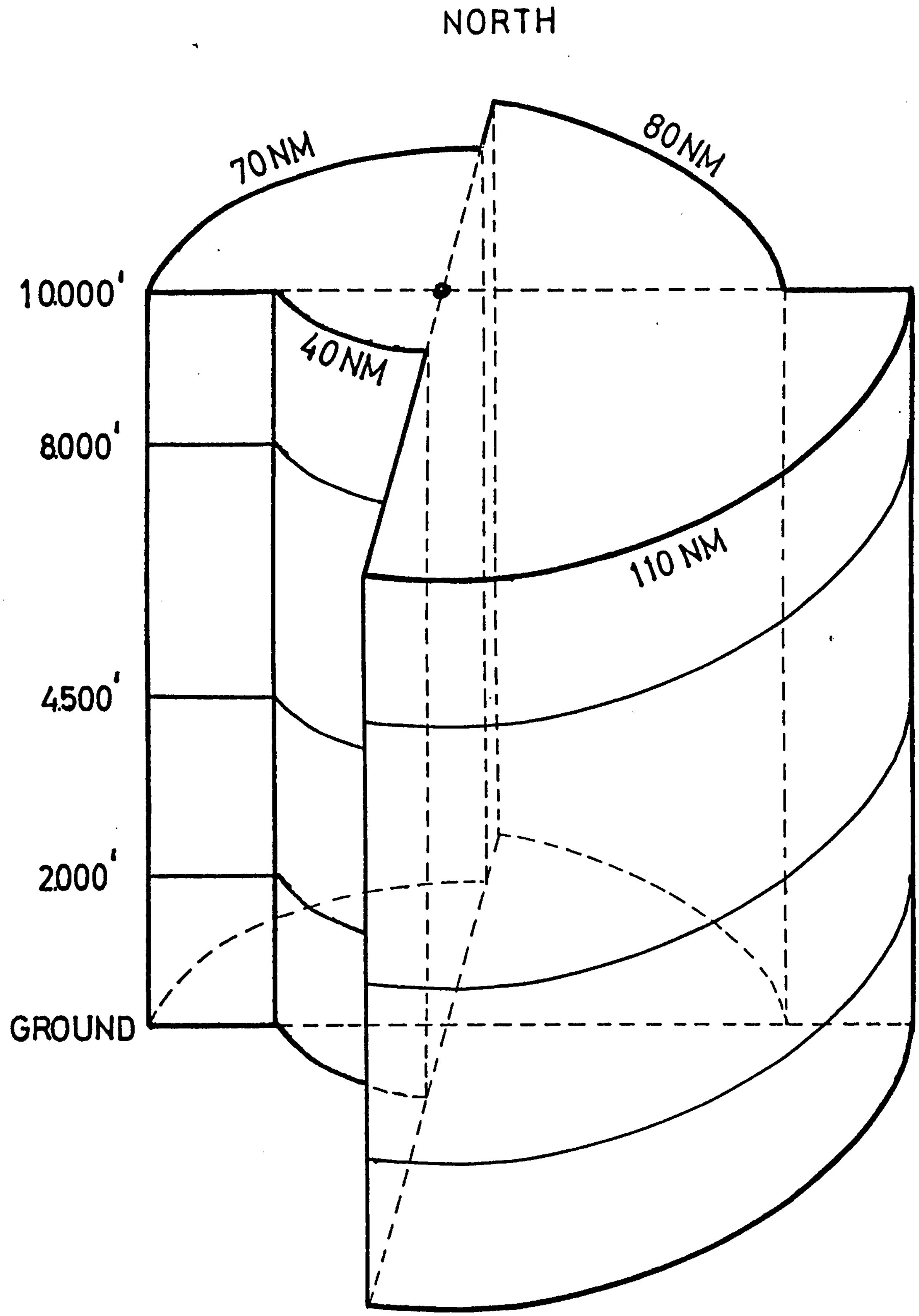
- FIRST TRY : SPRING 84
- TEST PERIOD : COMPLETE 84, SPRING 85
- SYSTEM OVERLOAD → SCOPE DEVIDED IN 4 QUADRANTS
- RANGE IN THE QUADRANTS : ADJUSTED
- A/C WITHOUT IFF : NOT COUNTED
- OBSERVATION ONE QUADRANT : 5 MIN.
- 4'30" : BUILDING-UP PHASE
- 30" : MOVING DISPLAY
- NEXT QUADRANT
- FINAL STEP : CALIBRATION

↓

DEFINE B.I.


N
80 NM
70 NM
40 NM
110 NM

HEIGHT LAYERS



ADF616061

BSCE 18/ WP 17
Copenhagen, May 1986

ENHANCEMENT OF F/RF-4 TRANSPARENCY SYSTEM BIRD IMPACT RESISTANCE*

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ABSTRACT

Birdstrikes to the crew enclosures of USAF F/RF-4 aircraft have resulted in major aircraft damages and severe pilot injuries. Analysis of operational bird impact statistical data indicates that the trend of damaging bird impacts of the F-4 is continuing to rise. Impacts to the F-4 transparency system also continue to rise resulting in a continued flight safety risk to the aircraft and the aircrew. The Air Force Wright Aeronautical Laboratories, Improved Windshield Protection Office has initiated a program to develop a transparency system for the F-4 aircraft which has four-pound, 500-knot bird impact capability. The first step in this program was to experimentally determine the existing transparency system capability by bird impact testing full-scale flight hardware. Eight impact locations on the windshield and forward canopy were tested to failure with four-pound birds. Tests on experimental, laminated windshield side panels were also conducted to investigate the capability of the windshield frame. The baseline birdstrike test results are presented through the use of post-test photographs, test films, and an impact capability diagram. Program progress subsequent to the baseline testing will be reviewed.

*Prepared for use at the Bird Strike Committee Europe meeting, 26-30 May 1986, Copenhagen, Denmark.

This is an update of the report, "Bird Impact Evaluation of the F/RF-4 Transparency System," prepared by Capt R. Simmons, AF Wright Aeronautical Laboratories, and G. Stenger, University of Dayton Research Institute. The report was presented at, and is included in the proceedings of, the FAA-sponsored conference and training workshop on Wildlife Hazards to Aircraft, 22-27 May 1984. Report #DOT/FAA/AAS/84-1.

BIRD IMPACT EVALUATION OF THE F/RF-4 TRANSPARENCY SYSTEM

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ABSTRACT

Birdstrikes to the crew enclosures of USAF F/RF-4 aircraft have resulted in major aircraft damages coupled with severe fatal pilot injuries. Analysis of operational bird impact statistical data indicates that the trend of damaging bird impacts of the F-4 is continuing to rise. Impacts to the F-4 transparency system also continue to rise resulting in a continued flight safety risk to the aircraft and the aircrew. The Air Force Wright Aeronautical Laboratories, Improved Windshield Protection Office has initiated a program to develop a transparency system for the F-4 aircraft which has four pound, 500 knot bird impact capability. The first step in this program was to experimentally determine the existing transparency system capability by bird impact testing full scale flight hardware. Eight impact locations on the windshield and forward canopy were tested to failure with four pound birds. Tests on experimental, laminated windshield side panels were also conducted to investigate the capability of the windshield frame. The baseline birdstrike test results are presented through the use of post test photographs and an impact capability diagram.

INTRODUCTION

Due to the advancement in radar detection techniques as well as the development and increased use of terrain following instrumentation, an increased amount of high-speed flight time is performed at altitudes below 10, 000 feet. Many air force high-speed aircraft transparency systems were not designed to meet the increased bird impact risk associated with this phase of the flight operation. The F/RF-4, Figure 1, is but one example of an aircraft which was not designed with a transparency system capable of surviving the bird impact event. Analysis of birdstrike statistical data obtained from the Air Force Inspection and Safety Center at Norton AFB, California shows that during the period January 1971 to March 1981, 30 of the 68 reported birdstrikes against the transparency resulted in penetration into the crew compartment. Associated with these penetrations were 12 injuries (some permanently disabling) to aircrew personnel, loss of one aircraft, and one pilot fatality. Recent birdstrike data continues to show an increase in the number of impacts and, without significant changes in the mission requirements that have resulted in this increasing birdstrike rate, an even larger number of damaging birdstrikes may be expected for the F/RF-4 aircraft in the future.

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BACKGROUND/OBJECTIVE

As a result of the loss of a USAF F-4E aircraft and a pilot fatality due to a windshield birdstrike in November 1980, the Improved Windshield Protection Program Office was directed to develop an improved bird impact resistant transparency system for the F/RF-4 aircraft. The initial phase of this program included an experimental test series which was conducted to determine the baseline bird impact capability of the current F/RF-4 transparency system.

The primary objective of this bird impact test program, conducted during the periods August-October 1982 and February 1983 was to determine the minimum bird penetration velocity as a function of birdstrike location for the windshield and forward canopy. Secondary objectives of the test program were to: (1) collect sufficient data (photographic, strain, and accelerometer) to support the subsequent transparency system redesign effort; and (2) to investigate the capability of the windshield support structure to absorb (and transfer into the fuselage) the energies associated with the bird impact event.

EXPERIMENTAL PROCEDURE

The bird impact testing of the F/RF-4 transparency system was accomplished at Range S-3 of the von Karman Gas Dynamics Facility of the Air Force System Command's Arnold Engineering Development Center. Figure 2 shows the test area arrangement. Capabilities of th S-3 Range are continued in Reference 1. The basic procedure employed in testing in the S-3 Range consists of launching bird carcasses at specified velocities (using an air-driven launcher) into predetermined impact locations on a test article. For the F-4 baseline tests, six impact locations on the windshield and forward canopy were investigated with the fuselage aligned at 0° pitch and 0° yaw relative to the launch path. Side impact tests were conducted at one location on the windshield side panel and one on the forward canopy with the fuselage yawed at 15° relative to the launch path.

Test Fixture/Test Articles

To more closely simulate the actual bird impact response of the transparency and to get realistic load transfer, an F-4 forward fuselage section was used as the test fixture (see Figure 3). All transparencies and related hardware were actual aircraft structures removed from aircraft in storage at the Military Aircraft Storage and Disposition Center at Davis-Monthan AFB, Arizona. Test articles consisted of the forward windshield assembly (two plexiglass side panels, laminated glass center panel, and supporting structure) and the forward canopy assembly. The cross-section of each transparency component is shown in Figure 4.

The windshield frame capability was determine by utilizing laminated side panels which were designed, developed, built, and donated by Goodyear Aerospace Corporation, Litchfield Park, Arizona. The laminated panel cross-section may be seen in Figure 5. When a transparency failed in a test, it was removed from the frame, the frame was inspected, and if no structural damage had occurred, another transparency was mounted in place.

Projectiles and Sabots

Projectiles launched during this test program were nominally four-pound chicken carcasses. The birds were asphyxiated, quick-frozen, and stored at 0°F until needed. Prior to testing, the carcass was thawed in still air at room temperature (75°F) for approximately 24 hours or until the body cavity temperature was 70 ±10°F. Adjustments to the bird carcass weights were required to achieve the desired weight within ±0.1 pound. These adjustments were accomplished by clipping carcass appendages or injecting water into the body cavity. In no case did the adjustment exceed 10 percent of the bird weight.

The packaged bird was mated to the launch tube using a one-piece sabot of balsa wood construction. The sabot materials density was nominally 10 lb/ft providing a sabot weight of 1.7 lb and a total launch weight of 5.7 lb. Separation of the bird and sabot after launch was accomplished with the use of the tapered and threaded cylindrical sabot stripping section attached directly to the vent section of the launch tube (Figure 2). As the launch package entered the stripper section, the sabot velocity was gradually decreased by the shearing of thin layers of sabot material, permitting the bird to exit in free-flight.

Instrumentation

Instrumentation for this series of tests was primarily designed to collect data for use with analytical transparency analysis tools. Four to five high-speed movie cameras were used to record the impact event. The cameras were situated in such a manner as to gain an overall perspective of the impact point (Figure 6). In addition to the high-speed cameras, still photographic coverage was used to record pre- and post-test conditions.

A total of 20 strain gages were monitored during each impact. These gages were located in such a manner as to record the load characteristics of the transparency support structure during impact.

Two accelerometers were used to monitor the motion of the frame during bird impact. X-ray shadowgraphs were used to monitor the bird position and orientation prior to the impact (Figure 2). They were also used to verify the impact velocity.

Test area temperature was measured by two thermocouples positioned near the test transparencies.

Impact Location/Impact Velocities

The eight impact locations used may be seen in Figure 7. These locations were chosen through the use of an angle of incidence study and represent areas where the maximum energy could be transferred from the traveling bird to the stationary structure. At least two impact locations on each transparency system component were investigated so that a capability map could be developed for the entire system. Impacts at locations "A" through "G" were made with the fuselage section aligned at 0° pitch and 0° yaw relative to the launcher flight path. Impact locations "H" and "I" were chosen to investigate the transparency capability in the sill area. Impacts at these two locations were

made with the fuselage yawed at a 15° (clockwise) angle so that sufficient bird contact could be made with the test article.

The initial impact velocity was slightly below the expected failure velocity. Failure velocities were analytically determined at each impact location by employing the prediction methods found in Reference 2. Succeeding impact velocities were increased until transparency failure at that location occurred. The failure velocity range could then be bracketed between the highest velocity at which failure had not occurred and the velocity at which failure had occurred.

TEST RESULTS

The baseline birdstrike capability for the F/RF-4 transparency system was defined with a total of 25 bird impacts at eight locations on the transparency system. The results of these tests have been summarized in a capability diagram as shown in Figure 8. This diagram presents the four-pound bird impact capability of the existing windshield system with the fuselage oriented at 0° pitch and 0° yaw. This diagram is based on the actual test data with the areas being defined after considering the recorded post-test observations, the high-speed movies, the strain data, the impact angle of incidence, and the proximity to the edge attachment. The values represent an approximate threshold of failure velocity (in knots) for various areas on the windshield and canopy.

Windshield Side Panel

The most critical impact location was on the forward area of the 0.38-inch thick stretched acrylic windshield side panel, impact point "A." The impact angle of incidence was 27 degrees at the target point. Impact point "A" was initially impacted with a four-pound bird at 190 knots which resulted in no damage. A subsequent shot at 200 knots resulted in about half of the four-pound bird penetrating the transparency (see Figure 9). The transparency frame was not damaged.

The aft area of the windshield side panel was tested at location"B" and was found to have a failure threshold of 210 knots. The small increase was due to the reduced angle of incidence: 21 degress.

Windshield Center Panel

The 1.2-inch-thick laminated glass windshield center panel demonstrated the highest capability of any part of the current transparency system. A four-pound, 300 knot shot on the forward end of the glass center panel (location"D") resulted in a substantial amount of glass spalling off the inside surface; however, no bird penetrated. A shot at 375 knots at location "D" resulted in the failure of the glass center panel. This test was classified a failure because much of the lower half of the transparency spalled into the cockpit, and the pilot would have been facing a considerable wind blast even though no bird actually penetrated (see Figure 10).

A four-pound, 375 knot shot was made on the aft end of the windshield center panel at location"C" and resulted in a small amount of the bird penetrating the windshield and canopy frames. Some glass was spalled into the

cockpit; however, neither the glass nor the bird would have posed a serious threat to the pilot, and this test was classified a pass.

A 450 knot shot at location "C" resulted in a substantial amount of spalled glass. In addition, the center panel was pushed down, buckling the windshield arch supports, and the bird impacted the forward frame of the forward canopy. This failed the canopy frame and transparency, resulting in several large pieces of spalled acrylic as shown in Figure 11. This test was classified a failure because of the potential injury to the pilot.

One shot was made at 300 knots on the sheet metal panel forward of the windshield center panel. Some bird penetrated the structure and the capability was estimated to be 250 knots.

Forward Canopy

The 0.30-inch thick stretched acrylic canopy was impacted seven times at three locations ("F," "G," and "I"). The demonstrated capabilities were 240 knots at location"F," 220 knots at location"G," and 230 knots at location"I." A 300 knot area was added in the capability diagram to reflect the decreased angle of incidence. No damage to the frame or support structure was found in any of the tests. The transparency, when failed, spalled several large pieces of acrylic (estimated at over 8 sq. in.), in addition to many small pieces. This spalled acrylic could cause serious injury to the pilot. Also, the pilot would be subject to considerable wind blast and buffeting through the large holes left in the transparency (Figure 12).

Windshield Frame

The capability of the F-4 production frame was determined by utilizing laminated panels formed in the F-4 side panel shape. The panels were mounted in the framework using aircraft grade bolts. Five impacts were made on the windshield structure with the laminated panels installed, one at location "A" and four at location "B." The impact at location A and the first impact at location "B" were performed at 450 knots with catastrophic failure of the frame occurring in both instances. The impact point "B" failure resulted in parts of the windshield arch entering the forward cockpit, posing a significant hazard to the pilot (Figure 13). For this reason, it was determined to perform additional tests at location "B." The three subsequent tests at location "B" resulted in a frame failure at a velocity of 375 knots. Failure at this velocity could have been predicted from a plot of the strain data taken at gage location GL4 (closest gage to the failure point) and the impact velocity (Figure 14). Note how rapidly the stress rises with velocity in this particular loading situation; the magnitude of the loads in the structure appear to be extremely sensitive to velocity in the 350-to-375 knot range. Frame baseline capability was accepted as 375 knots.

CONCLUSIONS

The F/RF-4 transparency birdstrike tests have established the existing capability of the transparency system and have generated a useful data base for designing and evaluating various bird impact resistant designs. In-field service has demonstrated the need for improved birdstrike protection and these tests confirm this need.

The data generated from these tests show that the acrylic side panels and forward canopy must be replaced with bird resistant designs which will provide the degree of protection required. Also, the tests indicated that a new or reinforced windshield frame is required.

A program currently under way will evaluate several alternative bird impact resistant transparency system designs. The result will be an affordable transparency system which will protect the F/RF-4 crew during high speed, low level flight.

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Figure 1. F/RF-4 Aircraft.

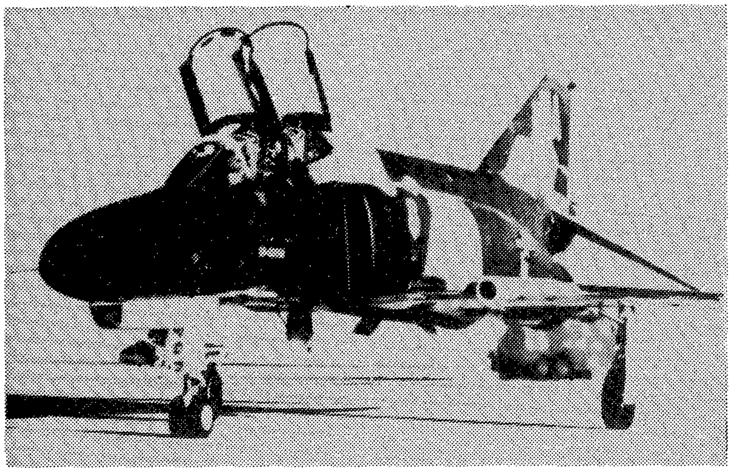


Figure 2. AEDC Test Area Arrangement.

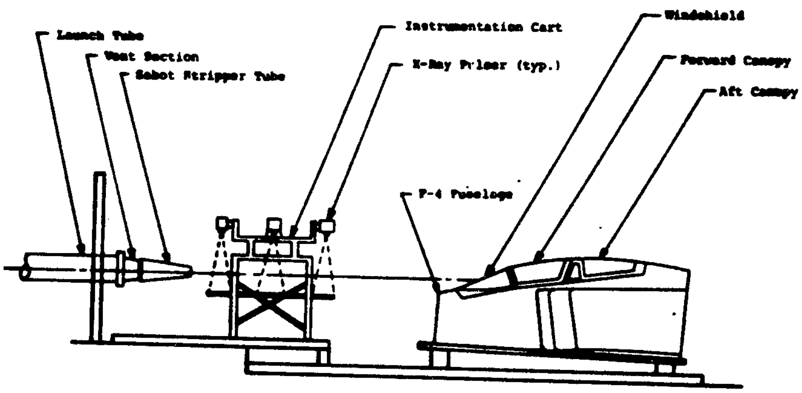


Figure 3. F-4 Forward Fuselage Installed in S-3 Range.

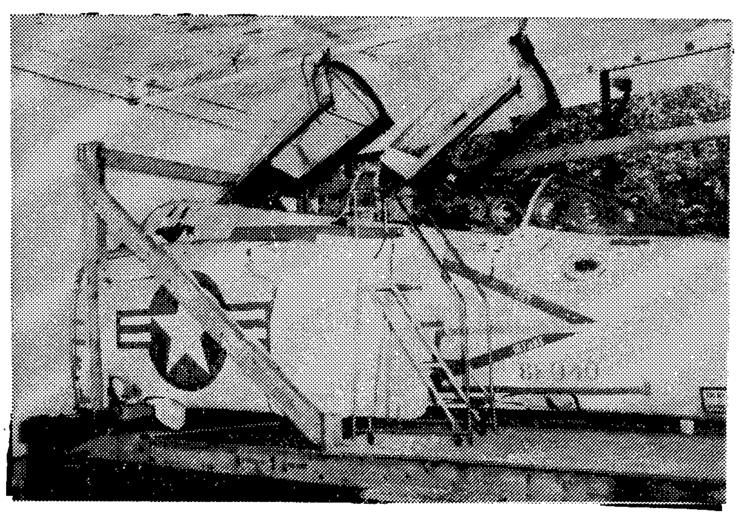


Figure 4. Cross-Sections of Production Transparency System.

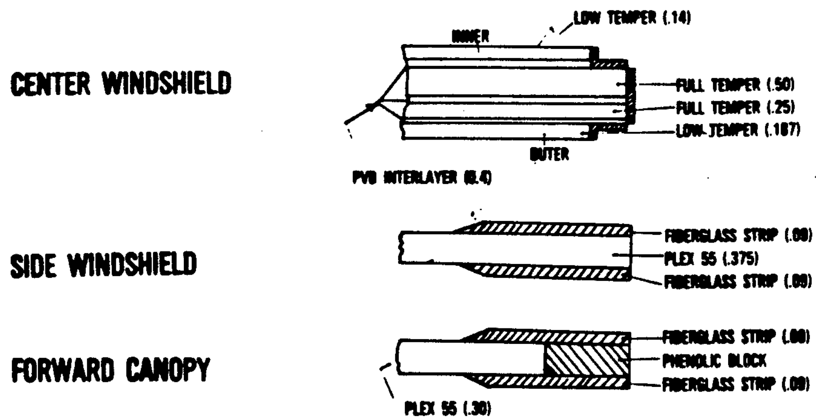


Figure 5. Laminated Side Panel Cross-Section.

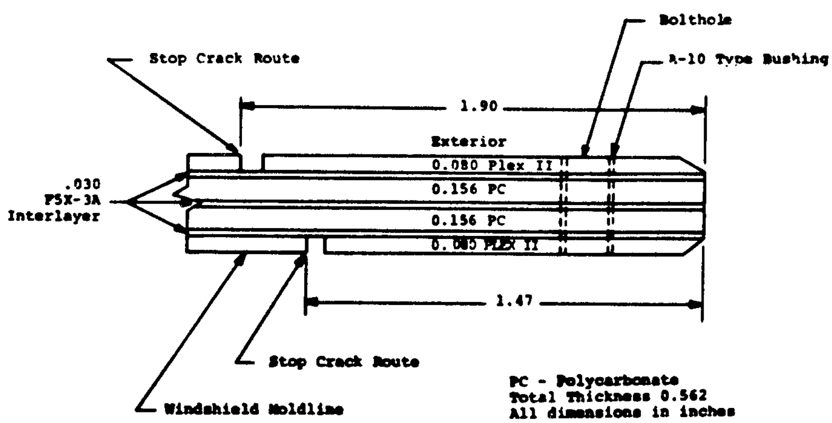


Figure 6. Location of Motion Picture Cameras.

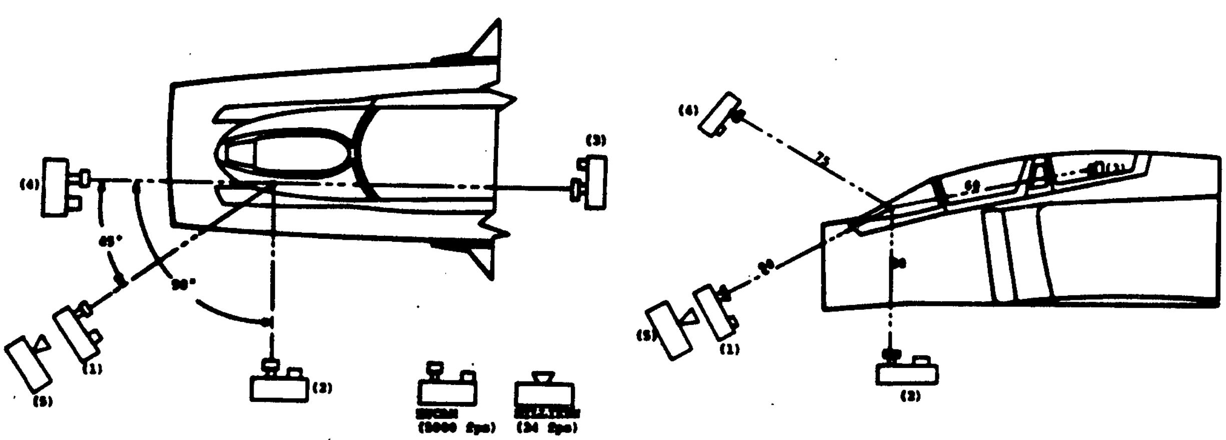


Figure 7. Impact Locations.

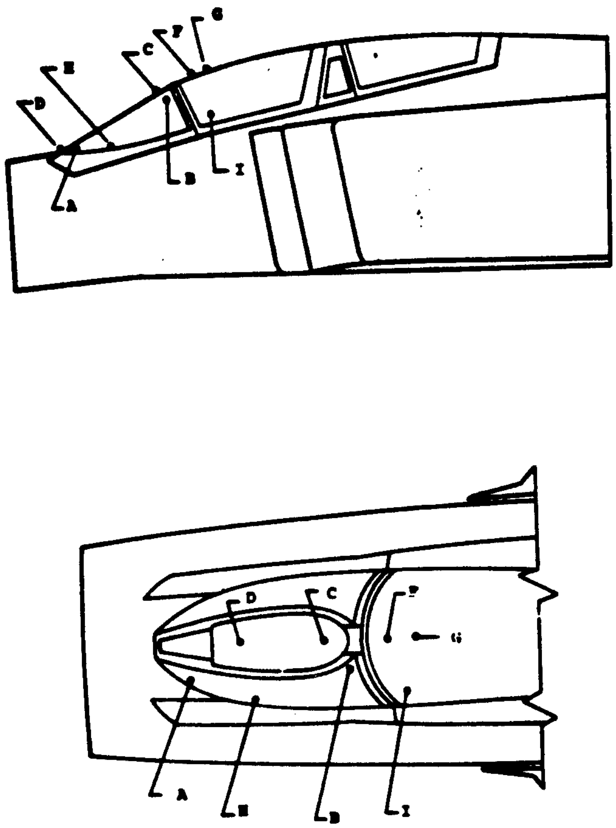


Figure 8. Bird Impact Capability Diagram.

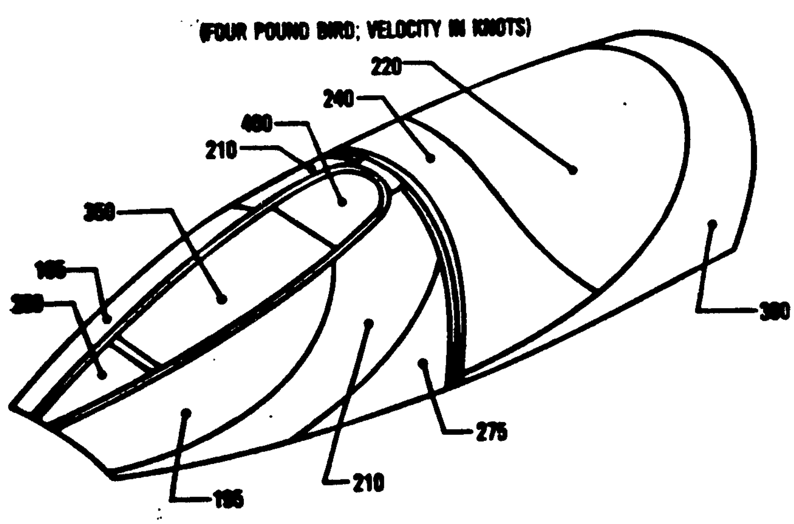


Figure 9. Post Test Damage, 200 Knot Side Panel Impact.

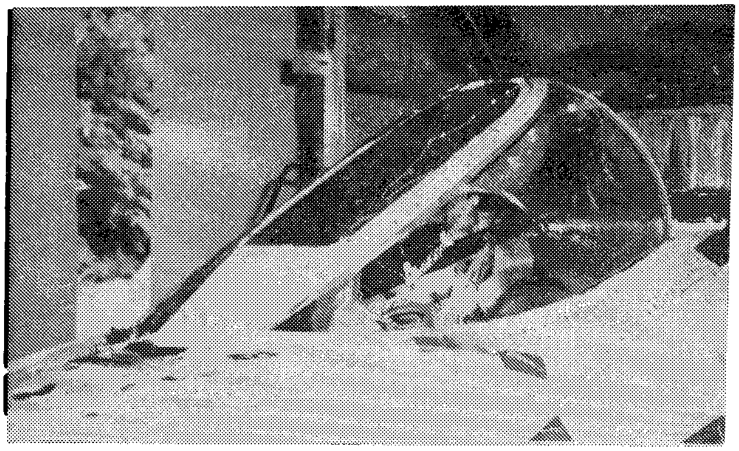


Figure 10. 375-Knot Impact Low on Center Panel.

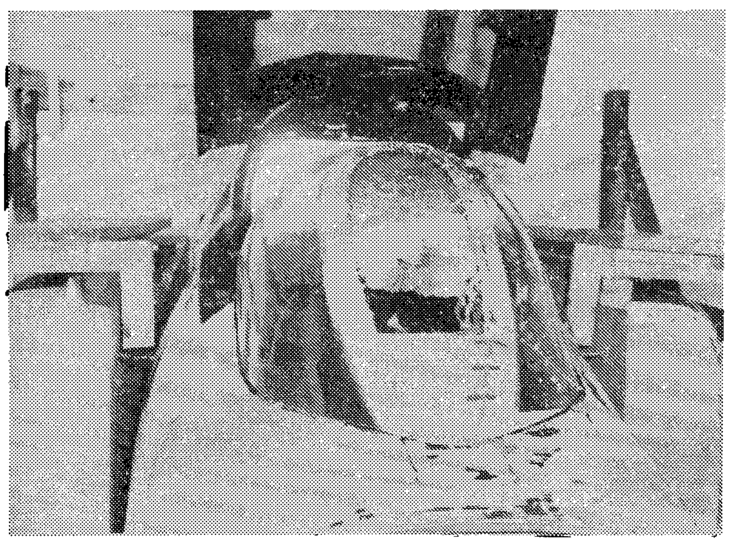


Figure 11. Post Test Damage, 450-Knot Impact Upper Center Panel.

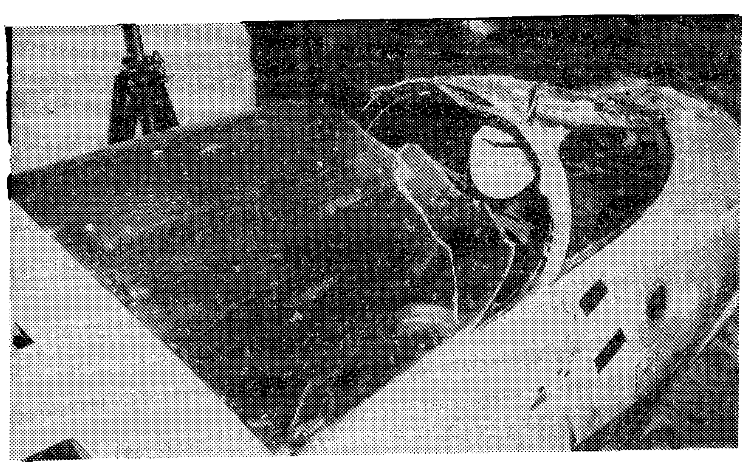


Figure 12. 270-Knot Impact, Centerline of Forward Canopy.

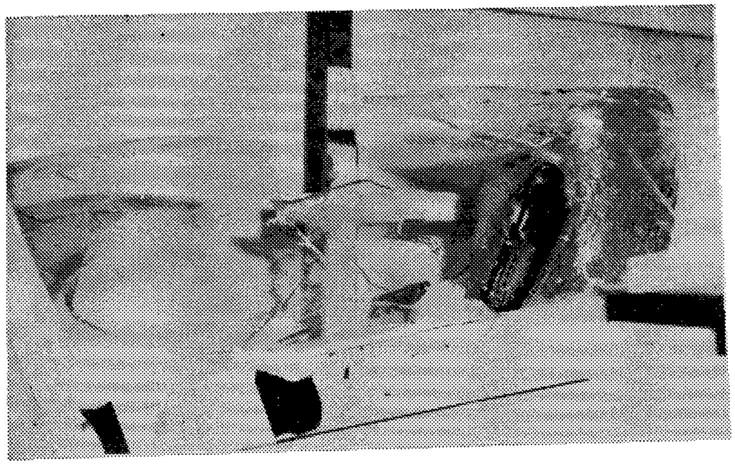


Figure 13. Failed Windshield Arch Fragments.

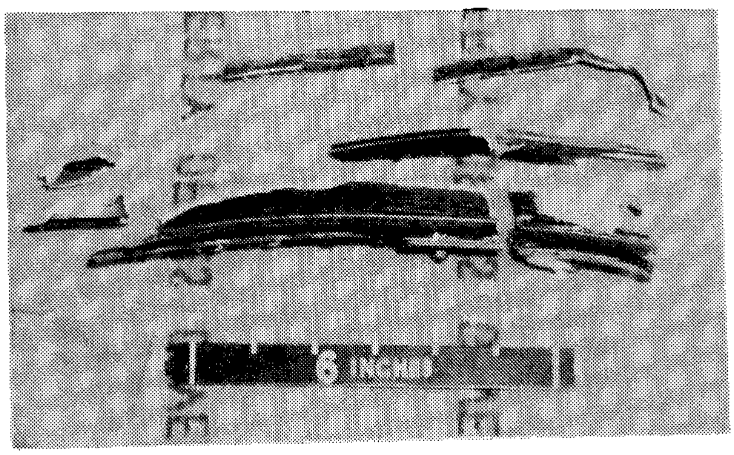
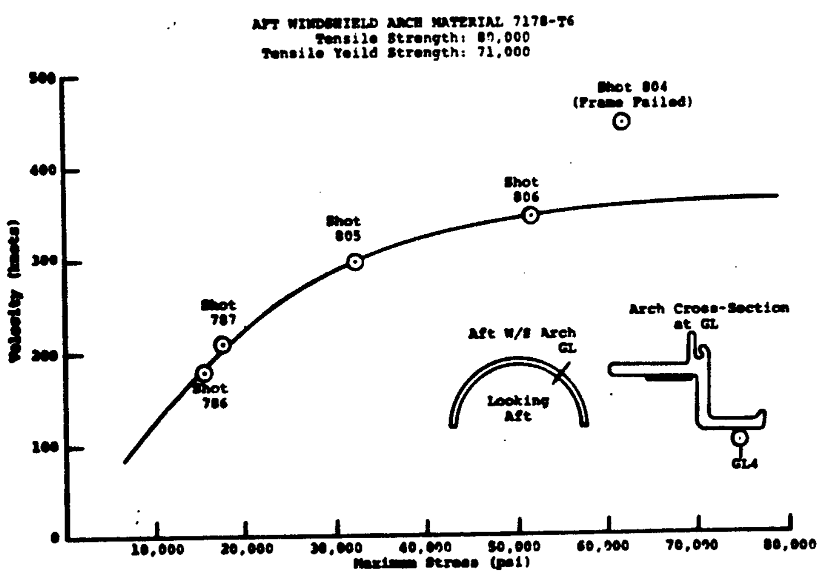


Figure 14. Maximum Stress vs. Velocity Gage GL4 Impact on Location B.



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BSCE 18/WP 18
Copenhagen, May 1986

LAST FRENCH EXPERIMENTS
CONCERNING BIRD-STRIKE HAZARDS REDUCTION
(1981-1986)

J.L. BRIOT - STNA/2N

FRANCE

SUMMARY This paper give briefly the results obtained in four differents experiments carried out in France since 1981 in civil aviation :

- Falconry,
- Radio controlled models aircrafts,
- Noisy synthetic sounds along the runways,
- On-board flashing lights.

I. FALCONRY

The results of two tests, at Toulouse-Blagnac in 1983/84 and Charles-de-Gaulle (Paris) in 1985/86, are summarized below:

- for only one of the species, the lapwing at Toulouse, the number of bird strikes went down by 75% during the 6-month test, which employed 2 full-time falconers in two 4-wheel drive vehicles and 5 peregrine falcons. However, no improvement was recorded for the other species, i.e. day and nights birds of prey. The airfield was medium-sized (800 hectares) and the problem was specifically caused by lapwings wintering there. The cost of the trials was $57 200 annually (photo 1).

- a check test was carried out on the same air-field in 1984/85 and 1985/86 with 2 full-time bird dispersal agents using conventional bird scaring equipment, i.e. distress calls, pyrotechnics means and hunting. Exactly the same results were obtained for an annual cost of $37 200.

- on a larger airfield of 3 200 hectares (Charles-de-Gaulle) with a more complex bird hazard problem (20 species involved), the bird strikes dropped by 60% for gulls, seagulls, lapwings and pigeons (the species hunted by the falconers) whereas the decrease was 30% fo all the species. The 8-month test with 3 falconers and 15 birds cost $100,000 per year. This method proved remarkably efficient for the scare duration, the areas covered (i.e. 400 hectares by a "good" falcon) and the motivation of the personnel. Nevertheless, the drawbacks cannot be ignored: the difficulty in finding qualified falconers, falcons (born in captivity) and goshowks (captured wild); the need for isolated quarters for accommodating the falconers and their birds day and night; the high cost of the method; the time necessary for training the falcons to be agressive, for keeping them and for retrieving them when they leave the airport area; the lack of effectiveness on several species such as other birds of prey, starlings and partridges; night and bad weather operations in fog, high winds, rain, very hot spells, etc.; the

question of airport responsibility for any falcon ingestion in a turbojet engine.

- in comparison, conventional means are much easier to operate, less costly and give very good results when used by motivated and competent staff. They are more concentrated around the runway and its verges but cannot clear large areas.

II. RADIO-CONTROLLED MODELS AIRCRAFTS.

Starting in 1981, close to 50 tests have been performed on airfields and domestic garbage dumps. The tests involved several species, such as black-headed gulls, WOOD PIGEONS, starlings and lapwings, and used 8 models with planforms representing large birds of prey, a small aircraft and geometric shapes (triangle, circle). The models were painted in different colours and powered by combustion engines or electric motors (photo 2). The model shape, colour and noise did not significantly affect the results.

After about 50 tests at Paris-Orly, Paris-Charles de Gaulle, Toulouse-Blagnac, and on waste-discharge sites, it appears that the shape, colour, and noise level of the model aircraft have no significant influence on the results obtained. Whatever the model aeroplane used, as soon as it takes off the birds on the ground rise also and flee the zone being overflown, before landing again a few hundred metres away.

In comparison to the attack by a diving falcon, the results are very different. The nuisance birds take off, but they never adopt the escape flight behaviour characterized by a rapid climb to about 500 metres altitude and then heading toward a fallback position a few kilometres away. In addition, the zone freed of birds by the model aircraft is only about 25 hectares (61.75 acres) whereas a well-trained falcon can keep 400 hectares (988 acres) free of nuisance birds, Furthermore, the scare-off time drops from several hours for a falcon to only several minutes for a model aircraft.

Finally, despite the refinement of the operational conditions (delta-wing model, robust, reliable, relatively cheap), this method remains more difficult to employ than falconry and also requires the full-time services of at least two employees per airport to operate the model aircraft with the requisite safety.

III. SYNTHETIC NOISE GENERATORS ALONG RUNWAYS

The method, which acoustically protects runways, is derived from the American "Av alarm" system. It consists of automatically generating intolerable artificial acoustic signals over the runways to prevent the birds from alighting. For a 3600-metre runway, the equipment includes a sound synthesis card with a microprocessor and 2 timers, 3 240-watt amplifiers and 24 30-watts loudspeakers spaced 150 metres apart (Photo 3). Developed by the Centre National de la Recherche Scientifique, the complex signals are a mixture of digitized distress calls with a required runway noise level of 75 dBA. The transmission sequences are random between 1 and 3 minutes and last for approximately 1 minute. In use on two thirds of the Orly (Paris) runways for the last 8 months, the device has resulted in an 80% improvement in bird strikes for black-headed gulls, wood pigeons, lapwings and starlings. The main advantages of this method are its very low cost, i.e. $14,000 per runway with a 10-year guarantee, and its completely automatic operation. Its drawbacks are the noise experienced by those living close to certain airports and the small area covered, i.e. only the 45-meter wide runway and its two 45-meter verges are protected, thus leaving large resting grounds unprotected for birds that may fly across the runway when disturbed. This system is being tried out on day birds of prey at Tarbes - Ossun - Lourdes.

IV. ONBOARD FLASHING LIGHTS

This experiment was designed to test the effectiveness of high power flashing lights on the bird scare distance. The idea here was to make the aircraft more apparent to the birds, causing them to fly away earlier, and thus to avoid collisions. An initial white flashing light unit of 10^6 candela RMS with a frequency varying from 1 to 5 Hz was tested on one vehicle. The vehicle was driven towards groups of birds on the ground with the flasher on or off and the scare distance measured, i.e. when the birds took off. The results from 145 tests on herring gulls, black-headed gulls, lapwings and rooks were as follows:

- the scare distance D increases with the frequency F (D = 51 meter at F = 4 Hz)

- groups of 25-30 birds are the most difficult to scare (D is large for isolated birds and large groups).

- even at high frequency, the difference in the distance D measured with and without flashes is not statistically significant (without flashing D = 35 m). A second test series was conducted using two white, 2 x 10^5 candela, lights flashing in alternate phase at 4 Hz and providing a beam at 2.5° elevation and ± 10° azimuth. The flashing units were installed on the wings of a light aircraft, the Robin 2160 (photo 4). The aircraft was flown at very low altitude and at various speeds over captive birds tied to the ground by a 1-2 meter long wire. The scare distance D was measured by tracking the aircraft with a cinetheodolite and stopping it when the birds took to the air - signalled by another observer. The aircraft noise was also recorded when the birds took off. The results of 105 tests mainly on corvidae (plus a few positive tests on domestic pigeons, black-headed gulls, and negative tests on grey partridge and common buzzard) are given below:

- there was no significant difference between the measured scare distance with (D = 154 m ± 20m) and without flashing (D = 153 m ± 18m)

- the scare distance doesn't change with aircraft speed (between 70 and 120 Kts)

- the noise does not affect the scare distance as the birds don't take off sooner if the aircraft is noisy (no difference between 63 and 70 dBL)

CONCLUSIONS

Falconry does not appear to yield better overall results than the fulltime use of conventional scare methods. The reduced-scale models were not effective and were difficult to pilot. The runway acoustic protection system seems to be very promising since it is as effective as the other methods but its cost is substantially less. If required, the system could be complemented by a fulltime agent employing the conventional techniques. The onboard flashing unit does not increase the scare distance between the aircraft and birds.

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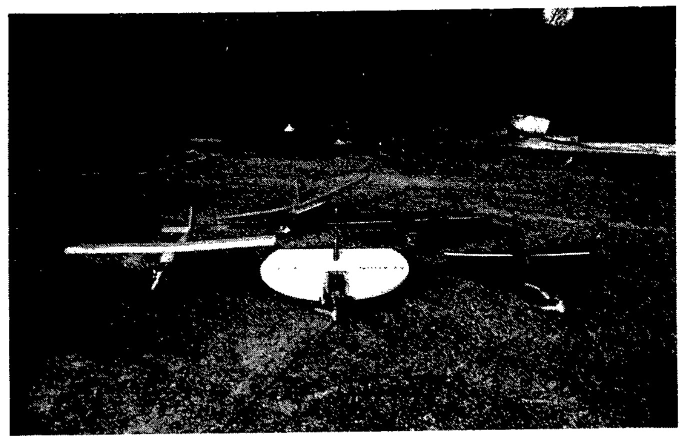

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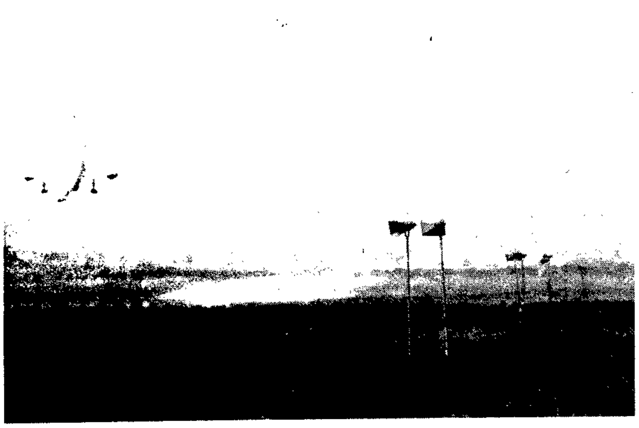

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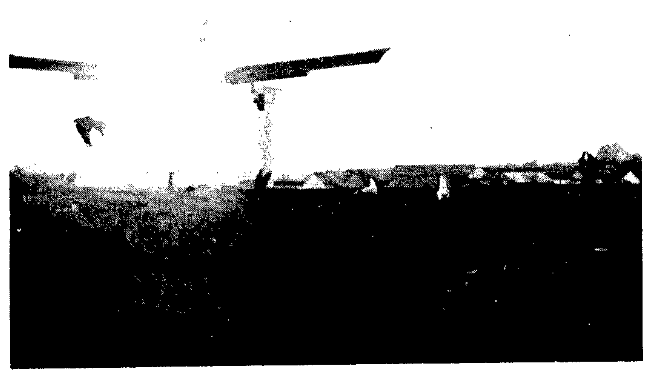

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BSCE 18/ WP 19
Copenhagen, May 1986

THE PROBLEM OF BLACK-HEADED GULLS (LARUS RIDIBUNDUS) BREEDING NEAR AIRPORTS.

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SUMMARY

Experiments with colour marking of Black-headed Gulls breeding on the island Saltholm 5 km east of Copenhagen Airport show that (1) the locally breeding gulls frequently visit the airport during the breeding season, (2) the radius of the feeding range is about 20 km (sometimes perhaps 40 km), (3) the scarcity of alternative feeding grounds within short distance of the colonies makes the airport a valuable feeding place, and (4) adults as well as juveniles tend to leave the breeding range soon after the end of the breeding season.

It seems likely that an increase of the breeding population during the last three years has caused a corresponding increase during the breeding season in the number of Black-headed Gulls occurring in the airport.

The effect of population control on the risk of strikes with Black-headed Gulls in the airport is discussed.

INTRODUCTION

A large number of Black-headed Gulls (Larus ridibundus) breed within distances of 5 and 15 km of Copenhagen Airport. There is a similar situation at Ålborg Airport in northern Jutland and probably also at other airports in Europe. These locally breeding gulls may influence the bird strike risk of the airports. In fact, studies on Herring Gulls (L. argentatus) breeding near Copenhagen Airport have shown that the large breeding population has great influence on the occurrence of Herring Gulls in the airport and it seems that a reduction of the population has reduced the strike rate significantly (Christensen et al. 1982, Lind & Glennung 1984).

The present paper describes the movements of a colour-marked breeding population of Black-headed Gulls on the island Saltholm near Copenhagen Airport and discusses the influence of the size of the breeding population on the bird strike risk in the airport.

BACKGROUND

Saltholm is an island in Øresund, approximately 5 km east of Copenhagen Arport. Since 1970 the Herring Gull population on the island has been reduced from about 40,000 pairs till about 9,000 pairs. Probably as a consequence of this the population of the Black-headed Gull has increased from only a few pairs in 1979 to 2,800 pairs in 1985. The majority breeds on the southern part of the island, i.e., on the part closest to the airport. In order to trace the movements of the Black-headed Gulls to their feeding areas 513 adult gulls were caught on their nests during the period May 13 - June 4, 1985. They were dyed with a solution of Rhodamin B in propyl alcohol on the breast and back and then released. The red colour was visible at a long distance and it did not seem to interfere with the breeding and social behavior of the birds. Unfortunately the breeding activity of the birds was greatly disturbed by foxes during the last two weeks of June, and therefore no youngs could be marked. The field work was carried out by Benni Hansen and Jesper Hansen from the university, and Jan Egerod, Jørgen Hagen and Jan Rasmussen from the airport.

The public was informed about the colour marking project in newspapers, periodicals and radio programs and asked to report observations of red gulls. Special efforts were made to get reports on the coloured gulls from the airport. A total of 1,164 observations were reported.

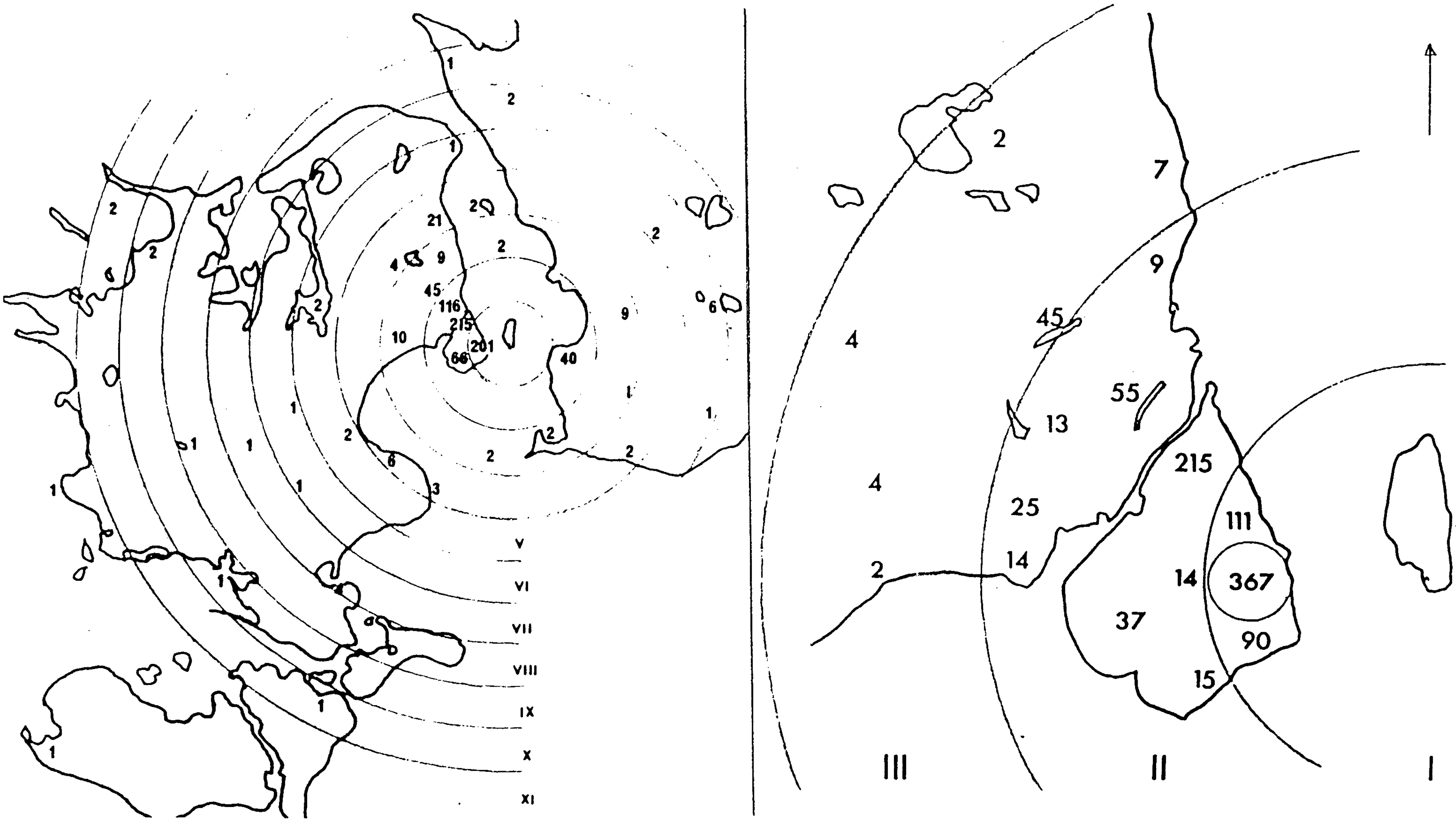
In a pilot project in 1984, 81 adults and 266 juveniles were colour marked and 156 observations were reported.

The bird scaring personnel of the airport has for many years made estimations of the number of (usually unspecified) gulls present on the grass areas several times a day. The daily maximum figures are used for demonstrating changes in gull numbers since 1980.

RESULTS

The geographic distribution of the 1985 observations of coloured Black-headed Gulls is shown in Figure 1. In 1984 the distribution was largely the same. The relatively large number of

FIGURE 1. The geographical distribution of the observations of marked Black-headed Gulls 1985. The figures are number of birds observed. The distance between the limits of the concentric regions, with the breeding colonies on Saltholm in the centre, is 10 km. On the map to the left observations from the airport are omitted.



observations from the airport, totally 367, is partly due to the high reporting intensity here. Occurrences on the Swedish side of the Øresund are probably underrepresented in the material. Observations on the behaviour of the birds in the colonies and analyses of radar films from May 1984 indicate that about 1/4th of the population feeds east of Saltholm. Most of the observations of marked gulls were made in the part of the Copenhagen area closest to Saltholm and thus in the area where the airport is situated. When excluding the observations in the airport 80% were made within a distance of 20 km from the breeding place and 95% within a 40 km distance (Fig. 2).

The frequency of reported observations decreased very fast during the latter half of June and was low in July (Fig. 3). In the airport there was a maximum frequency in the first half of June, and after the middle of June very few marked gulls were seen on the grass areas, whereas they still occurred in other places, among buildings, in hangar areas, etc. (Fig. 4).

Far-distance observations were made during the whole recording period, among others in Jutland and the Netherlands in June.A few marked birds were reported from breeding colonies in the Copenhagen and Malmø areas.

In 1984 marked gulls, adults as well as juveniles, were observed more frequently during July than in 1985. In the 1st and 2nd half of June 20 and 40 observations, respectively (adults only), and per half month from July to mid-September 38, 68, 3, 0, and 2, respectively (adults and juveniles). Also in 1984 far-distance observations occurred during the whole reporting period.

In the airport a general increase in the number of gulls has taken place in the months April-July during the last years, whereas the changes in number from year to year in March and August-October have been rather variable. Most days the Black-headed Gull was the more frequent species, only when large numbers of gulls occurred (more than 500) there usually was a majority of Herring Gulls. Reports from the bird scaring personnel strongly indicate that the increasing gull numbers are mainly due to an increase in the number of Black-headed Gulls.

Figure 5 compares the recent development in gull numbers in the airport during the breeding season with the development of the gull populations on Saltholm. It can be seen that the increasing gull numbers in the airport are nicely correlated with the growth of the colonies of Black-headed Gulls.

Table 1 shows the frequency of gull strikes in the airport 1978-85; in about half the cases the birds were collected for species identification. As can be seen the number of strikes vary from year to year without showing any tendency to either increase or decrease.

FIGURE 2. The frequency distribution of observations of marked gulls in the regions I-XI, i.e. the distance from the breeding place. The upper part of the first column represents observations in the airport.

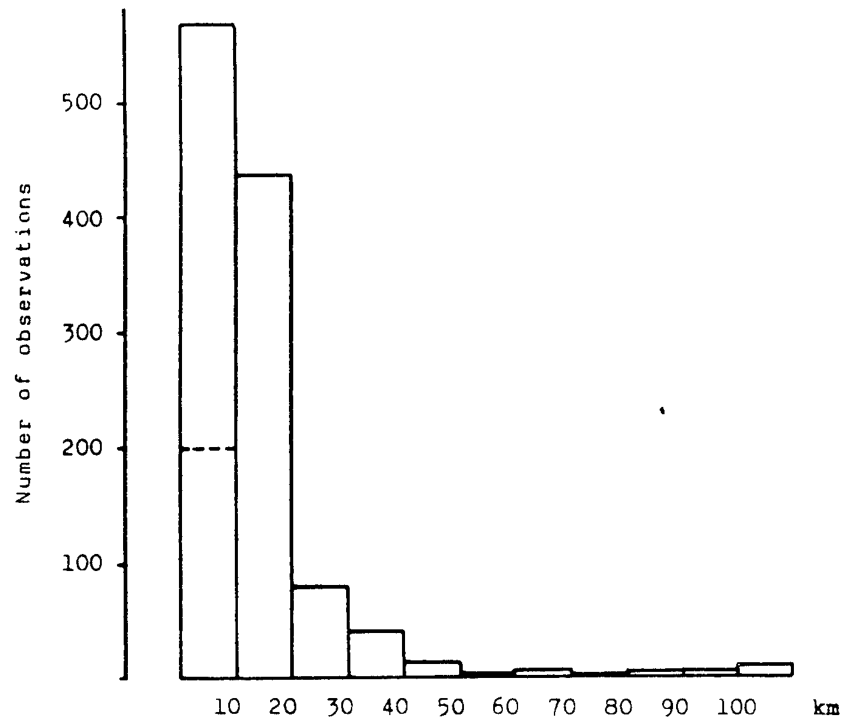


FIGURE 3. The reporting frequency of marked gulls per half month periods. The frequency (f) is calculated on basis of numbers of observations (n), marked gulls (m) and days in the period (d),

$$f = \frac{n \times 100}{m \times d}.$$

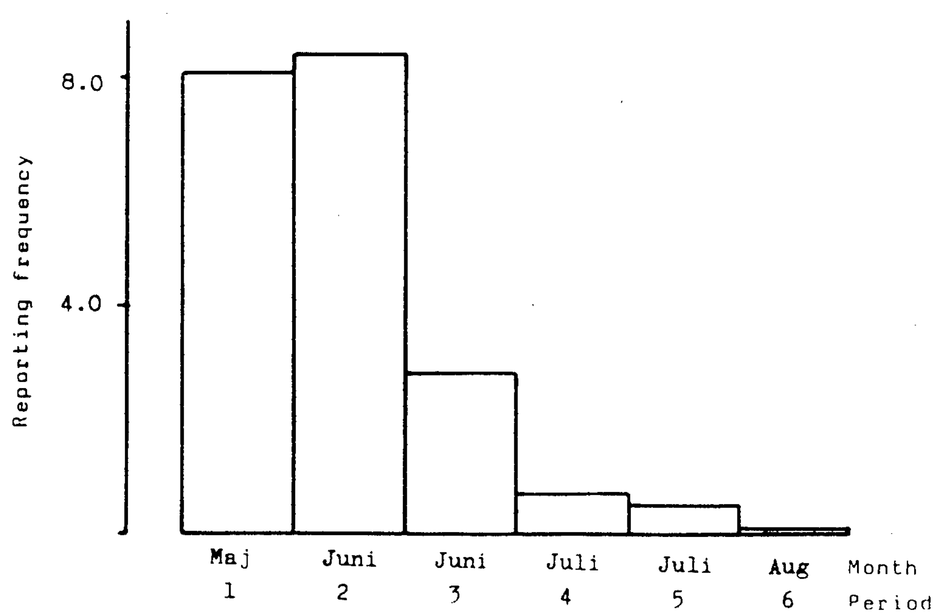


FIGURE 4. The reporting frequency of marked gulls in the airport. To the left reports from the airport area exclusive of the grass areas along the runways and to the right only reports made by the bird scaring personnel on the grass areas.

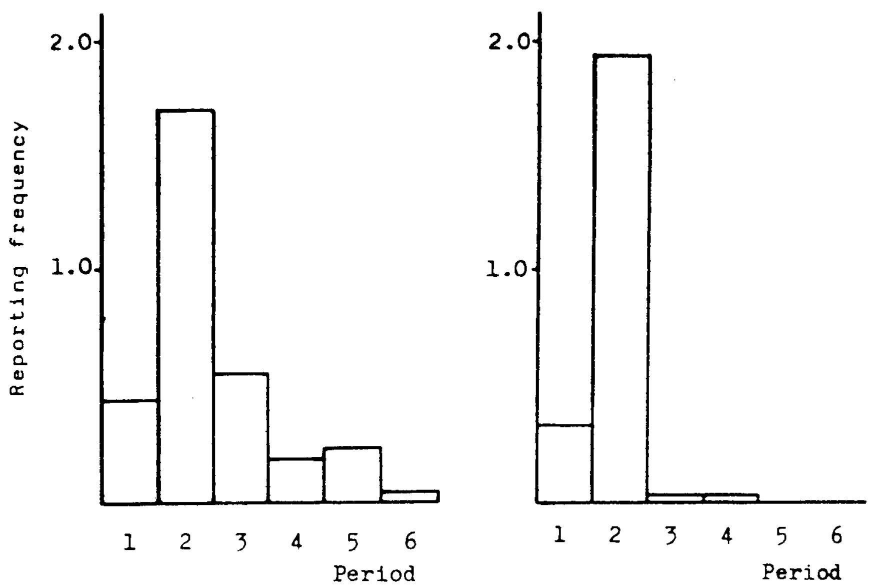


FIGURE 5. The development during the years 1980-85 of the gull frequency in the airport in April-June measured by the mean number of days per month with maximum number of gulls ≥ 100 (●) and ≥ 200 (○) and of the breeding populations of Black-headed Gulls (□) and Herring Gulls (■) on Saltholm.

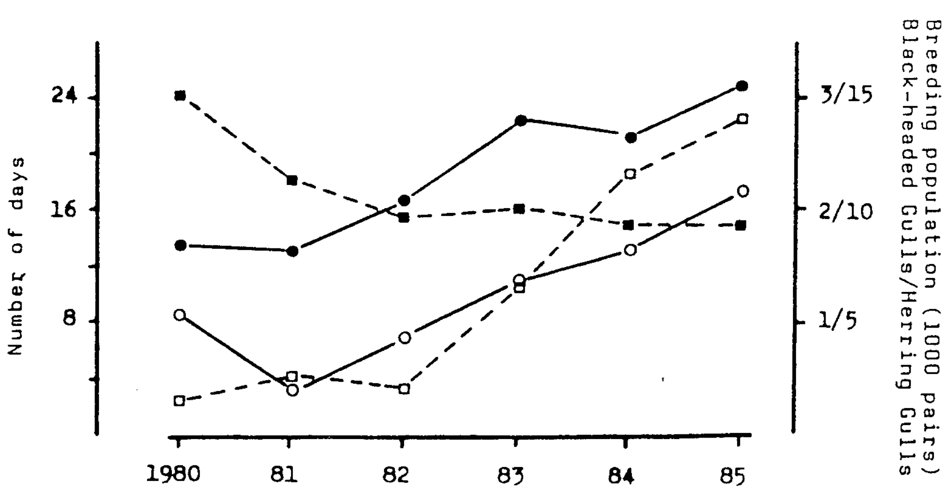


TABLE 1. The number of recorded gull strikes in the airport 1978-85.

	1978	1979	1980	1981	1982	1983	1984	1985
Black-headed Gull	3	2	1	3	1	7	1	2
Herring Gull	6	4	8	5	5	8	4	4
Common Gull	2	1	6	2	4	3	2	4
"Gulls"	5	11	15	4	17	10	12	11
Total	16	18	30	14	27	28	19	21

DISCUSSION

The large number of reports on marked birds gives a fairly good picture of the feeding range of the Saltholm population. It extends to distances of about 20 km, and some days probably 30-40 km. It includes city and suburban as well as agricultural areas and wetlands on both sides of Øresund. The airport is certainly visited very often; it is shown directly by the high reporting frequency here and indirectly by the relatively high number of reports from Amager, the island where the airport is situated.

The rapid decrease in number of observations already in June is remarkable. It might partly be explained by waning interest in reporting observations, however, there were no obvious signs of this in 1984. Moulting in adults usually starts i July (Cramp 1983) and may gradually have reduced the colouration of the birds. Moulting might therefore explain a decrease in reported observations from about mid-July, but not in June. The main reason probably is that after having given up breeding due to disturbances in the colonies the birds very soon left the breeding range and dispersed over the country. A number of reports from distant places supports this explanation. The reason why the short-distance reports in June were not replaced by a similar number of long-distance reports in July probably is that the information about the project was poorer in other parts of the country.

The results of the 1984 study indicate that in normal years the breeding population, including the juveniles, disperses by the end of July. Ringing results in Denmark and other countries also indicate that many adults as well as juveniles move away from the breeding range rather soon after the end of the breeding season. (Salomonsen 1972).

The present results show that the grass areas in the airport are frequently used for feeding by the nearby breeding population. However, they also show that the utilization of the grass areas declined as soon as the breeding activity ceased due to disturbances in the colonies. Probably the grass areas in the airport because of the short distance from the colonies present valuable food resources when the need for food is high, i.e., when the gulls have youngs to feed; at other times the gulls may visit better feeding grounds at longer distances. This means that the pressure by the gulls on the airport grass areas in normal years declines already during the first half of July even if the birds are still present in the area.

In a large breeding colony of Black-headed Gulls (10,000 pairs) a few kilometers from Ålborg airport, northern Jutland, colour marking studies (using picrin acid) have been carried out for the last 3 years (Junker-Hansen 1986). It seems that the gulls use the airport for feeding less frequently than they do in the Copenhagen Airport, probably because there are several alternative feeding grounds at the same or even shorter distances. Most of the gulls, like the Saltholm gulls, leave the breeding range within a month after the end of the breeding season.

We now know that the Black-headed Gulls from Saltholm frequently use the airport for feeding, and therefore it seems very likely that the increasing number of gulls in the airport during the breeding season is due to the growth of the population of Black-headed Gulls on Saltholm. It might therefore be considered to control the breeding population and thereby achieve a reduction in the gull numbers in the airport and reduce the risk of strikes with aircrafts. It should, however, be remembered, firstly, that the effect of a control program probably will be rather small outside the breeding season (August-March) and, secondly, that Black-headed Gulls from other colonies within a distance of about 20 km will still visit the airport during the breeding season. One large colony of 12,000 pairs is found approximately 15 km to the northwest of the airport.

We should expect that the more gulls in the airport, the higher is the bird strike risk (and vice versa). However, so far the number of reported strikes with Black-headed Gulls or other gulls have not increased. It may be due to inconsistent recording of strikes, but there may also be other explanations. Perhaps the present magnitude of the increase in gull numbers (e.g., from 100 to 300 per day, or from 1 day per week with 200 gulls to 3 days per week with 200 gulls) is of no significance to the strike risk. Or perhaps locally breeding individuals visiting the airport regularly and becoming accustomed to the conditions there cause relatively few bird strikes. If the latter explanations are correct, the effect of population control would be even smaller than indicated above.

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ADF616064 SE/bb D.13

Landbrugsministeriets Vildtforvaltning

BSCE 18/WP 20
Copenhagen, May 1986

Report on permissions granted by the Wildlife Administration in 1985 concerning deviation from the general rules of hunting and capture of birds in the Act of Hunting and Wildlife Administration, in which the Council Directive of April 2, 1979 on the conservation of wild birds has been incorporated.

The untermentioned is an exhaustive recital of the permissions concerning wildfowl which the Wildlife Administration has issued for deviation of the general rules concerning open seasons and methods of capture in the Ministry of Agriculture's Act Order No. 57 of February 11, 1983 in which the Council Directive of April 2, 1979 concerning conservation of wild birds is incorporated. The permissions have been granted according to the mentioned directive Article 9 and primarily announced after Sections 25 and 33 in the above act together with Sections 7 and 17, Subsection 2 in the Ministry of Agriculture's Order No. 654 of December 10, 1982 concerning regulation of noxious game.

Furthermore birds shot in airfields and authorized runways according to Section 6 in the mentioned Order in the period April 1, 1984 - March 31, 1985 are recited.

Permissions issued by wildlife advisers:

97 permissions to regulate goshawk **Accipiter gentilis**, sparrow hawk **Accipiter nisus** and common buzzard **Buteo buteo** at sites where quarry birds are reared.

5 permissions in July to shoot grey lag-goose **Anser anser** injuring crops.

45 permissions to capture pheasants **Phasianus colchicus** for breeding. The permissions in question allow capture of a total of 13,070 individuals.

Permissions issued by the Wildlife Administration:

Capture:

2 permissions to capture waders sp. and house-sparrows **Passer domesticus**, respectively for scientific purposes.

10 permissions to capture mallards **Anas platyrhynchos** in lakes where the population has grown too big.

Regulation of noxious game:

8 permissions to regulate cormorants **Phalacrocorax carbo sinensis** near stationary fishing tackle, 1 permission to regulate cormorant juveniles in one colony, 6 permissions to regulate gulls **Larus sp.**, 4 permissions to regulate rooks **Corvus frugilegus**, 2 permissions to regulate wood pigeon **Columba palumbus** and 1 permission to regulate collared dove **Streptopelia decaoto**.

Marking:

1 permission to mark gulls **Larus sp.**

Airports:

1 permission to use goshawk **Accipiter gentilis** to frighten away birds in the Aalborg Airport area. Information from the airports has been received, saying that the following number of birds have been shot in the period April 1, 1984 - March 31, 1985 according to Section 6 in Order No. 654 of December 10, 1982 concerning regulation of noxious game:

3,840 gulls **Larus sp.**, 389 pigeons **Columba sp.**, 181 oystercatchers **Haematopus ostralegus**, 119 crows **Corvus corone cornix**, 4 jackdaws **Corvus monedula**, 51 rooks **Corvus frugilegus**, 58 magpies **Pica pica**, 2 marsh harriers **Circus aeruginosus**, 1 kestrel **Falco tinnunculus**, 9 common buzzards **Buteo buteo**, 1,396 starlings **Sturnus vulgaris**, 13 golden plovers **Charadrius apricarius**, 680 lapwings **Vanellus vanellus**, 68 sparrows sp., 1 curlew **Numenius arquata**, 11 mallards **Anas platyrhynchos**, 5 redshanks **Tringa totanus**, 2 tufted ducks **Aythya fuligula**, goosander **Mergus merganser**, 3 woodcocks **Scolopax rusticola**, 1 tern sp., 3 swans sp., 29 partridges **Perdix perdix**, 9 pheasants **Phasianus colchicus**, 66 fieldfares **Turdus pilaris**, 1 grey heron **Ardea cinerea**, 36 swallows sp. and 4 greenshanks **Tringa nebularia**.

Miscellaneous:

29 permissions to taxidermists for dealing with corvids.

ADF616065

BIRD STIKE COMMITTEE EUROPE

BSCE 18/WP 21
Copenhagen, May 1986

BIRD STRIKES DURING 1983 TO EUROPEAN REGISTERED CIVIL AIRCRAFT

(Aircraft over 5700 kg Maximum Weight)

J Thorpe - UK
R van Wessum - Netherlands

SUMMARY

The strikes reported throughout the World in 1983 by operators from fourteen European countries have been analysed. The analysis includes rates for countries, aircraft types and aerodromes based on aircraft movements. It also covers bird species, part of aircraft struck, effect of strike, and airlines affected.

The strike rate in 1983 was at 5.6 per 10,000 movements, somewhat higher than the two previous years. Gulls (Larus spp.) were involved in 35% of the incidents. The major effect was damage to 122 engines.

CONTENTS

This study is based on information supplied and the accuracy and detail are only as good as that reported. Any opinions expressed are those of the author.

1 INTRODUCTION

1.1 In order that a common basis for the analysis of bird strike data could be agreed, a Working Group of the Bird Strike Committee Europe was formed in 1972, led by the representative from the United Kingdom Civil Aviation Authority Airworthiness Division at Redhill. Reports covering the individual years 1972 to 1982 inclusive have been presented to BSCE meetings. This paper contains the 1983 analysis.

1.2 Appendix 1 contains the Tables of data relating to this paper.

2 SCOPE

For the following reasons, the analysis includes all civil aircraft of over 5700 kg (12 500 lb) maximum weight, and executive jets which weigh just less than 5700 kg, eg Lear and Citation.

(a) the airworthiness requirements relating to bird strikes are different for the smaller class of aeroplanes,

(b) much more is known about the reporting standards of operators of transport types, and their movement data is more readily available than that for air taxi or private owner aircraft.

(c) aircraft of less than 5700 kg are in general, much slower with a different mode of operation, requiring less airspace, and a noticeably different strike rate would be expected.

3 DISCUSSION

3.1 Annual Rate/Country (See Table 1)

(a) Information has been obtained from a total of fourteen European countries. A few of these were not able to provide full information, and their data therefore, appears in some tables and not in others.

(b) The overall strike rate for the 1894 incidents contained in this analysis is 5.6 per 10,000 movements (two movements per flight). This is greater than the rate of 4.6 recorded during 1982 (4.3 in 1981).

(c) The strike rate reported by each country is dependent upon two major factors -

- reporting standard

- the bird strike problem at airports within that country, and that country's airlines route structure.

(d) The country with the highest reported strike rate and possibly the most efficient reporting is Ireland with 10.7 per 10,000 movements, followed by Switzerland with 9.1.

3.2 **Aircraft Types** (See Table 2)

(a) Jet Aeroplanes

(i) For several years there appears to have been no consistent correlation between aircraft of similar design, eg DC8 and B707, DC10 and L1011. It may be that aircraft which appear similar to humans are not similar to birds, and there are other factors such as noise patterns, which can affect the strike rate. There is some difference in the strike rate of 4, 3 and 2 engined jets.

(ii) The BAe146, DC10, A300 and A310 have above average strike rates.

(iii) The aircraft with the greatest damage rate are the IL62, Mercure, A300, A310 and small sample of Cessna Citations.

(iv) 26% of strikes to 4 engined jet powered aircraft cause damage while for three and two engined aircraft only 8% result in damage.

(b) Turboprop Aeroplanes

The average strike rate for all Turboprops is 4.0 compared with 5.8 for jets. The damage rate is the same as for jets.

(c) Piston Aeroplanes

Only two strikes were recorded to the small number of piston engined aeroplanes.

(d) Helicopters

The number of strikes reported to helicopters is very low, only 17. Because helicopters fly mainly at low altitude where birds are most frequently found, they are continuously exposed to the risk of a strike. Therefore flying hours have been used to determine a strike rate. For reasons which are not at present known, the rate is low at 1.2 per 10,000 hours, but somewhat less than the 2.0 of 1982. There was only one case of damage to a helicopter.

3.3 **Aerodromes** (See Table 3)

(a) The aerodrome data is of particular importance as it may indicate where bird control measures need to be taken. Some countries were able to provide aerodrome movement data for their nationally registered aircraft, so that a national rate could be quoted.

The total number of strikes at each aerodrome, reported by all European sources has also been included.

(b) Strikes reported on aerodromes are influenced by one or more of the following:

   (i) reporting standards

   (ii) the prevailing bird situation which may vary according to place and time

   (iii) the number of aircraft movements

   (iv) the effectiveness of bird control measures

   (v) local factors, perhaps beyond control of the aerodrome, eg a rubbish dump or bird roost site in the vicinity.

(c) Because of factors outlined in (b), direct comparison of the reported strike rates for different aerodromes is likely to be misleading.

(d) European Aerodromes with five or more damaging strikes are Brussels (5), Frankfurt (8) and Amsterdam (5). This may in some cases be a reflection of the aerodrome movements, local bird populations and reporting efficiency.

(e) Significant numbers of strikes have been reported at aerodromes outside Europe. Fourteen strikes were reported at Bangkok and ten at Bombay. Three of the strikes at Nairobi resulted in damage.

3.4 <u>**Bird Species**</u> (See Table 4)

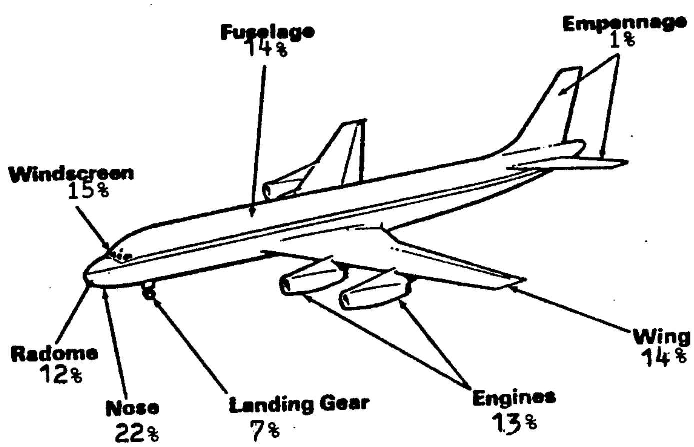
Some knowledge of the bird species involved was available in 65% of incidents. The identification standard ranged from examination of bird remains by a trained ornithologist to the fleeting glance of a pilot. Overall 35% of strikes involved gulls (Larus spp.) of which the Black-headed gull (Larus ridibundus) was the most frequently identified. This is similar to 1982. Next on the list was the combination of swift/swallow/martin at 18%, and the Lapwing (Vanellus vanellus) with 13%. Birds of Prey accounted for 8%. Only one incident was believed to involve a bird heavier than 1.81 kg (4 lb).

Gulls were involved in 50% of damaging incidents (but 35% of strikes) where the birds involved were known.

The birds struck during the last four years are summarised overleaf. There does not appear to be a clear trend.

Birds	YEAR 76	77	78	79	80	81	82	83
Gulls (Larus spp.)	44	41	41	41	41	45	33	35
Lapwing (Vanellus vanellus)	14	10	11	10	12	9	14	13
Birds of Prey (Falconiformes)	8	9	8	8	10	12	9	8
Pigeons (Columba spp.)	7	9	7	7	7	7	7	8
Swift/swallow/martin	11	12	13.5	18	15	11	13	18

3.5 **Part of Aircraft Struck** (See Table 5)



From the figure the parts most frequently reported as being struck can be seen.

It should be noted that there were 29 incidents where more than one engine was struck, of which 20 affected all engines (seven in both 1981 and 1982 involved all engines).

3.6 **Effects of Strikes** (See Table 6)

(a) During 1983 a total of 120 engines were damaged such as to require repair or replacement. Of these 56 were on twin engined aircraft. It appears that 50% of reported engine strikes involved engine damage.

(b) Only two windscreens were changed, a small number compared with the 264 windscreen strikes. None of these were known to involve penetration.

(c) There were 11 cases of radome damage, out of 211 radome strikes. In most cases the radome was only delaminated, but in a few cases it was shattered. The radome strength is limited by the need for dielectric properties enabling satisfactory operation of the weather radar.

3.7 Cost

The number of countries able to provide cost information was too small to warrant analysis.

3.8 Aircraft Operator Reporting (See Table 7)

This table provides a guide to the reporting efficiency and problems of individual airlines. It is probable that it is considerably affected by the airport(s) at which the airline has its main base.

4 CONCLUSIONS

4.1 The overall rate for the 1894 strikes reported during this period by European operators is 5.6 strikes per 10,000 movements. This rate is slightly higher than in previous years.

4.2 There does not appear, from the available data, to be any close correlation between the strike rate and the aeroplane type in terms of speed, engine type etc.

4.3 Some aircraft for reasons which are unknown, have a much higher strike rate eg BAe146, DC10, A300 and A310, whilst others have a higher rate of damage.

4.4 The percentage of strikes which cause damage is three times greater on 4 engined jet powered aircraft than on 3 or 2 engined aircraft.

4.5 There are some airports outside Europe where the number of bird strikes reported by European operators is high even though movements by European registered aircraft at these airports are believed to be low. Damage occurred at several of these airports.

4.6 Gulls (Larus spp.) were struck more frequently than other birds, being involved in 35% of incidents where the bird species were known. Less than 1% of birds struck were believed to be greater than 1.8 kg (4 lb).

4.7 The nose section including the windscreen and radome were reported as being struck in 49% of incidents, with engines being struck in 17%. There were 29 incidents where more than one engine was struck.

4.8 The major consequences were damage to 120 engines, and to 11 radomes. There were no aircraft written off, or occupants injured.

APPENDIX 1

BIRD STRIKE ANALYSIS

EUROPEAN OPERATORS 1983

CIVIL AIRCRAFT OVER 5700 kg (12,500 lb) MAXIMUM WEIGHT

Notes:

0.1 The following are not included in this Analysis:

(a) aircraft of maximum weight 5700 kg (12,500 lb) and under, except for those few executive jets, which have been included, eg Lear and Citation.

(b) all military type and operated aircraft.

0.2 All Tables are for strikes reported worldwide.

0.3 The Total columns of many of the tables are different, as some countries have not been able to provide full information for every table.

TABLE 1 NATIONAL REPORTING - 1983

(A high rate may be due to efficient reporting)

Reporting Nation	Number of Incidents Worldwide	Damaging Incidents	Number of Movements Worldwide	Rates per 10,000 Movements	
				Damage	All
Austria	26	N/A	54,200*	N/A	4.8
Belgium	29	8	106,736	0.7	2.7
Czechoslovakia	17	7	46,916*	1.5	3.6
Denmark	47	N/A	166,448	N/A	2.8
Finland	29	4	134,882	0.3	2.1
France	222 (23)	57 (5)	466,381	1.2	4.8
Germany	389 (15)	63 (5)	469,696*	1.3	8.3
Ireland	64 (7)	N/A	59,810*	N/A	10.7
Italy	185	3	200,452*	0.1	9.2
Netherlands	77	9	189,557	0.4	4.1
Norway	(70)	N/A	N/A	-	-
Sweden	68	6	181,476	0.3	3.8
Switzerland	169 (3)	6 (1)	188,972*	0.3	9.1
United Kingdom	487 (34)	30	994,970	0.3	4.9
TOTAL	1,809 (152)	193 (11)	3,260,416	0.6	5.5

Notes:

1.1 There are two movements per flight.

1.2 * Movement data from ICAO Sources.

1.3 Helicopters are excluded from this Table.

1.4 The figures in brackets are strikes for which no movement data is available.

1.5 Damage rate excludes those countries who did not supply damage information.

Aircraft Type	Number of Countries Reporting	Number of Incidents	Damage			All	Number of Movements	Strike Rate per 10,000 Movements Damage	All
JET									
BAE 146	1		-			12	10,710	-	11.2
IL 62	1		3			7	9,306	3.2	7.5
Boeing 707/720	4		6			20	29,658	2.0	6.7
Boeing 747	11		35		(1)	116	174,385	2.0	6.6
McDonnell Douglas DC-8	8		2		(2)	21	33,694	0.6	6.2
Concorde	2		1			1	4,987	-	2.0
All 4 engined Jets			47	26%	(3)	177	262,748	1.8	6.7
McDonnell Douglas DC10	11		18		(6)	141	118,637	1.5	11.9
Lockheed 1011 Tristar	2		2			37	46,506	0.4	7.9
HS Trident	1		-			56	74,958	-	7.5
Boeing 727	5		9			193	324,466	0.3	5.9
TU134	1		4			8	25,626	1.6	3.1
YAK40	1		-			-	6,314	-	-
All 3 Engined Jets			33	8%	(6)	435	596,507	0.5	7.3
A300 Airbus	4		25		(1)	138	150,668	1.7	9.2
A310 Airbus	4	(1)	3		(2)	17	21,192	1.4	8.0
Boeing 737	9		43		(12)	412	622,589	0.7	6.6
DA01 Mercure	1		8			28	47,958	1.7	5.8
Boeing 757	1		-			12	21,600	-	5.6
HS125	3		3		(1)	9	50,246	0.6	1.8
SE 210/212 Caravelle	4		8			40	72,904	1.1	5.5
BAC 1-11	2		3			99	199,016	0.2	5.0
McDonnell Douglas DC-9	11	(1)	5		(50)	268	621,450	0.1	4.3
Cessna 500/550 Citation	2		2			2	5,440	3.7	3.7
Fokker F28	2		3		(3)	35	128,868	0.2	2.7
DA20 Jet Falcon	4		-		(3)	-	1,924	-	-
Learjet 35	6	(1)	-		(6)	-	5,464	-	-
SN 601 Corvette	1		-			-	3,628	-	-
Mitsubishi MU300	1		-			-	300	-	-
HFB 320 Hansa	1		-		(2)	-	-	-	-
All 2 Engined Jets		(3)	103	10%	(80)	1,068	1,953,247	0.5	5.5
ALL JETS		(3)	183	11%	(89)	1,680	2,812,502	0.65	6.0
TURBOPROP									
IL 18	1		-			2	5,670	-	3.5
DHC 7	3		-		(1)	11	32,814	-	3.4
BAC Viscount	1		1			8	28,664	-	2.8
BAC Merchantman	1		-			1	1,782	-	-
Short Belfast	1		-			1	1,322	-	-
HS Argosy	1		-			-	2,040	-	-
L188 Electra	1		-		(1)	-	-	-	-
All 4 Engined Turboprops			1	4%	(2)	23	72,292	-	3.2
BAE Jetstream	3	(1)	21		(2)	78	96,792	2.2	8.1
HS 748	1		2			28	51,514	0.4	5.4
Short SD3-30	2		-		(7)	23	74,038	-	3.1
HP Herald	1		1			9	31,736	-	2.8
Fokker F27	4		5			50	191,222	0.3	2.6
Nord 262	2	(1)	-		(1)	1	7,670	-	-
DHC6 Twin Otter	2		-		(2)	-	466	-	-
SA227 Swearingen Metro	2		-		(3)	-	7,092	-	-
All 2 Engined Turboprops		(2)	29	15%	(13)	189	460,530	0.6	4.1
ALL TURBOPROPS		(3)	30	14%	(15)	212	532,822	0.6	4.0

PISTON						
Bristol 170 Freighter	1	-	-	286	-	-
Douglas DC3 Dakota	1	-	2	5,646	-	3.5
ALL PISTON		-	2	5,932	-	3.4
UNKNOWN (assumed fixed wing)			(41)	-	-	-
TOTAL (including unknown)		(6) 213	(145) 1,894	3,351,256	0.6	5.6

Helicopter Type	Number of Countries Reporting	Number of Strikes		Number of Hours	Strike Rate per 10,000 Hours	
		Damage	Total		Damage	Total
Sikorsky S61N	3	1	11(6)	51,715	-	1.2
Westland WG30	1	-	-	1,480	-	-
Boeing Chinook	1	-	-	9,465	-	-
Aerospatiale Puma	1	-	-	25,901	-	-
ALL HELICOPTERS		1	11(6)	92,965	-	1.2

Notes:

2.1 Because of the low altitude of operation at heights where birds normally fly, and difficulty in collection of movement data, helicopters are quoted in hours.

2.2 The figures in brackets are for aircraft for which hours data is unavailable.

2.3 Where the number of incidents, or the number of movements is small and particularly where they are both small any derived rate should be treated with caution.

2.4 Damage data not supplied by Austria, Denmark, Ireland and Norway.

TABLE 3 AERODROMES - 1983

(A high rate may be due to efficient reporting)

Country/Aerodrome	Incidents	Movements	Rate per 10,000 Movements	Incidents To Other European Aircraft	Total Damage	Total All
AUSTRIA						
Graz	1	-	-	-	-	1
Klagenfurt	3	-	-	-	-	3
Linz	2	-	-	1	-	3
Salzburg	3	-	-	3	-	6
Vienna	17	-	-	6	-	23
BELGIUM						
Brussels	19 (5)	-	-	11	5	30
Ostend	1 (1)	-	-	-	-	1
CZECHOSLOVAKIA						
Bratislava	3 (2)	-	-	-	2	3
Liberec	1	-	-	-	-	1
Prague	4 (2)	-	-	-	2	4
DENMARK						
Aalborg	-	-	-	3	-	3
Beldringe	1	-	-	-	-	-
Billund	1	-	-	-	-	-
Copenhagen	14	60,164	2.3	20 (1)	1	34
Esbjerg	6	-	-	-	-	-
Ronne	4	-	-	-	-	-
Vagar	1	-	-	-	-	-
FINLAND						
Helsinki-Vantaa	14 (1)	84,466	1.7	1	1	15
Kajaani	1	3,556	2.8	-	-	1
Kemi	2	11,314	1.8	-	-	2
Kuopio	3	41,398	0.7	-	-	3
Kuusamo	1	1,546	6.5	-	-	1
Lappeenranta	2	8,044	2.5	-	-	2
Mariehamn	9 (1)	6,614	13.6	-	1	9
Oulu	2	19,578	1.0	-	-	2
Pori	2	17,772	1.1	-	-	2
Tempere-Pirkkala	3	20,438	1.5	-	-	3
Turku	2	31,472	0.6	-	-	2
Varkaus	1	3,758	2.7	-	-	1
FRANCE						
Basle-Mulhouse	3	6,722	4.4	-	-	3
Bastia	3	6,984	4.3	-	-	3
Beauvais-Tille	2	61	327.8	2	-	4
Biaritz	-	-	-	1	-	1
Bordeaux	7	15,845	4.4	-	-	7
Brest	5	5,837	8.5	-	-	5
Calvi-Ste Catherine	3	2,368	12.6	-	-	3
Grenoble	3	3,617	8.3	-	-	3
Istres-Le Tube	1	1,117	17.9	-	-	2
Lourdes-Tarbes	3	928	32.3	-	-	3
Lyon-Satolas	15	38,995	3.8	-	-	15
Marseille-Marignane	11	35,462	3.1	4	-	15
Montpeillier-Frejorgues	9	9,332	9.6	-	-	9
Nice-Cote D'Azur	3	31,092	0.9	4	-	7
Nimes-Garons	4	2,658	15.0	-	-	4
Perpignan	9	3,693	24.3	-	-	9
Paris Le Bourget	2	6,191	3.2	3	-	5
Paris Charles de Gaulle	25	63,310	3.9	20	-	45
Paris Orly	32	114,701	2.8	-	-	32
Saint Brieve	2	1,803	11.1	-	-	2
Strasbourg-Entzheim	4	10,711	3.7	-	-	4
Toulouse-Blagnac	23	17,141	13.4	1	-	24

GERMANY					
Berlin	-	-	-	2	-	2
Braunscweig	2	-	-	-	-	2
Bremen	5	6,721	7.4	-	-	5
Cologne/Bonn	14	19,493	7.2	2	-	16
Dusseldorf	50 (4)	50,440	9.9	1	4	51
Frankfurt	58 (8)	114,709	5.1	4	8	62
Hamburg	19 (4)	36,043	5.3	3	4	22
Hannover	9 (1)	18,094	5.0	-	1	9
Munster	1	-	-	-	-	1
Munich	33 (1)	56,952	5.8	3	1	36
Nurnberg	5	13,764	3.6	-	-	5
Saarbrucken	1	4,115	2.4	-	-	1
Stuttgart	18 (4)	26,407	6.8	-	4	18
Paderborn	1	-	-	-	-	1
Oberpfaffenhofen	1	-	-	-	-	1
GREECE						
Athens	-	-	-	3	-	3
Corfu	-	-	-	9	-	9
Reus	-	-	-	2 (1)	1	2
Rhodes	-	-	-	1	-	1
Thessalonika	-	-	-	1	-	1
Zakinthos	-	-	-	2	-	2
IRELAND						
Dublin	38	-	-	2	-	40
Cork	8	-	-	2	-	10
Shannon	10	-	-	1 (1)	1	11
ITALY						
Bari	3	5,398	5.5	-	-	3
Cagliari	5	12,718	3.9	-	-	5
Catania	-	-	-	1	-	1
Genoa	-	-	-	1	-	1
Milan-Linate	30	78,238	3.8	15 (2)	2	45
Milan-Malpensa	4	14,563	2.7	4 (1)	1	8
Naples	3	19,016	4.2	3	-	6
Olbia	5	6,784	7.4	2	-	7
Rome-Fiumicino	29	134,438	2.1	11	-	40
Ronchi	3	5,586	5.4	-	-	3
Venice	13	16,032	8.1	8	-	21
NETHERLANDS						
Amsterdam	27 (3)	69,976	3.8	12 (2)	5	39
Eindhoven	1	7,356	1.4	-	-	1
Enschede	-	1,564	-	-	-	-
Groningen	-	1,134	-	-	-	-
Maastricht	1	4,432	2.3	-	-	1
Rotterdam	-	4,866	-	1 (1)	1	1
NORWAY						
Alesund	3	12,225	2.4	-	-	3
Alta	1	7,230	-	1	-	2
Bergen	5	32,053	1.6	-	-	5
Bodo	4	28,141	1.4	1	-	5
Kristiansand	2	12,256	1.6	-	-	2
Molde	2	6,357	3.1	-	-	2
Oil Rigs	5	-	-	-	-	5
Oslo-Fornebu	17	67,790	2.5	8	-	25
Stavanger	5	32,085	1.6	1	-	6
Tromso	5	18,707	2.7	3	-	8
PORTUGAL						
Faro	-	-	-	1	-	1
Lisbon	-	-	-	9 (1)	1	9
SPAIN						
Alicante	-	-	-	5	-	5
Barcelona	-	-	-	8	-	8
Gerona	-	-	-	2	-	2
Ibiza	-	-	-	9	-	9
Madrid	-	-	-	3	-	3
Mahon	-	-	-	2	-	2
Malaga	-	-	-	12	-	12
Minorca	-	-	-	4	-	4
Palma de Mallorca	-	-	-	8	-	8
Vitoria	-	-	-	1 (1)	1	1

Angelholm	10 (3)	5,200	19.2	-	3	10
Goteborg-Landvetter	3	30,900	0.1	2	-	5
Halmstad	4	3,500	11.4	-	-	4
Jonkoping	2	6,100	3.3	-	-	2
Karlstad	4	2,900	13.8	-	-	4
Malmo-Sturup	6	10,900	5.5	2	-	8
Stockholm-Arlanda	6 (1)	83,500	0.7	7	-	13
Stockholm-Bromma	6	35,000	1.7	-	-	6
Umea	3	10,500	2.9	-	-	3
Visby	2	5,800	3.5	-	-	2
SWITZERLAND						
Basle-Mulhouse	2	-	-	-	-	2
Geneva	16 (1)	-	-	4	1	20
Zurich	43	-	-	10 (2)	2	53
UNITED KINGDOM						
Aberdeen	18 (1)	68,313	2.6	-	1	18
Belfast-Aldergrove	12	22,696	5.3	1	-	13
Birmingham	21	23,116	9.1	2	-	23
Blackpool	4	8,874	4.5	-	-	4
Bournemouth-Hurn	4 (1)	17,363	2.3	-	1	4
Bristol Lulsgate	2 (1)	5,267	3.8	-	1	2
Cardiff-Wales	4	6,867	5.8	-	-	4
East Midlands	7	20,099	3.5	-	-	7
Edinburgh	22	22,320	9.9	2	-	24
Gatwick	22 (3)	80,711	2.7	-	3	22
Glasgow	37 (3)	40,931	9.0	-	3	37
Hatfield	9	-	-	-	-	9
Heathrow	38 (1)	135,193	2.8	13	-	51
Humberside	2	7,708	2.6	-	-	2
Kirkwall	4	8,472	4.7	-	-	4
Leeds/Bradford	8	9,849	8.1	-	-	8
Liverpool	3	18,381	1.6	1	-	4
Luton	16 (2)	20,789	7.7	-	2	16
Lydd	4	3,446	11.6	-	-	4
Manchester	32 (1)	41,443	7.7	2	1	34
Newcastle	24 (1)	13,263	18.1	-	1	24
Norwich	12	14,520	8.3	-	-	12
Prestwick	-	-	-	1 (1)	1	1
Ronaldsway I of M	4	11,458	3.5	2	-	6
Stansted	4	11,977	3.3	2	-	6
Sumburgh	3	11,523	2.6	-	-	3
Tee-side	5	10,428	4.8	-	-	5
Oil Rigs	6	-	-	-	-	6

LIST OF AERODROMES WHERE MORE THAN ONE STRIKE, OR ONE STRIKE WITH DAMAGE HAS BEEN REPORTED BY EUROPEAN OPERATORS

Bangkok	14	Melbourne	3 (1)
Bombay	10 (1)	Moscow	3
Instanbul	9 (1)	Abu Dhabi	2
Nairobi	9 (3)	Accra	2 (1)
Guernsey	8	Addis Ababa	2
Colombo	7	Djerba	2
Karachi	7	Mane Island	2
New York JFK	7 (1)	Motevideo	2 (1)
Delhi	6 (1)	Muscat	2 (1)
Las Palmas	6 (1)	Toronto	2 (1)
Tel Aviv	5	Algiers	1 (1)
Dar Es Salaam	4 (2)	Bujumbaru	1 (1)
Jersey	4	Burgas	1 (1)
Kilimanjaro	4 (1)	Cairo	1 (1)
Malta	4	Djibouti	1 (1)
Mombasa	4 (1)	Doha	1 (1)
Tanger	4	Los Angeles	1 (1)
Budapest	3	Port Santo	1 (1)
Casablanca	3	San Juan	1 (1)
Dakar	3 (2)	Sofia	1 (1)
Dalaman	3	Tripoli	1 (1)

En Route	30
Unknown	25

Notes:

3.1 Because of variability in reporting, bird population, aircraft movement pattern, control measures and features beyond control, any comparison between the rates calculated for different aerodromes is likely to be misleading.

3.2 The figures in brackets are incidents with damage. (Not supplied by Austria, Denmark, France, Ireland and Norway.)

3.3 UK data on Strikes New Aerodromes (between 500 ft and 2,500 ft) have been excluded (21 incidents) as have carcasses found on aerodromes with impact damage.

TABLE 4 BIRD SPECIES - 1983

Scientific Name	English Name	Weight	Weight Category	Number of Incidents Damage	Number of Incidents Total	% Based on 1227
PELICANIFORMES						
Pelecanidae	Pelican	up to 6 kg	D	-	1	-
CICONIIFORMES						
Ardea cinerea	Grey heron	1.5 kg	B	-	1	-
Botaurus stellaris	Bittern	950 g - 1.7 kg	B	-	1	-
Bubulcus ibis	Cattle egret	345 g	B	-	1	-
Ciconia sp	Stork	up to 3 kg	C	1	1	-
ANSERIFORMES						
Anas sp	Duck	250 g - 1.3 kg	B	-	6	0.5
FALCONIFORMES						
Buteo sp	Buzzard	260 g - 1.3 kg	B	1	18	1.5
Buteo buteo	Common buzzard	800 g	B	-	5	0.4
Accipiter sp	Hawk	up to 1 kg	B	-	16	1.3
Accipiter nisus	Sparrow hawk	190 g	B	-	1	-
Accipiter gentilis	Goshawk	1 kg	B	-	1	-
Milvus sp	Kite	780 g - 1.0 kg	B	1	6	0.5
Milvus migrans	Black kite	780 g	B	2	12	1.0
Falco sp	Falcon	105 g - 1.3 kg	B	1	17	1.4
Falco columbarius	Merlin	195 g	B	-	1	-
Falco tinnunculus	Kestrel	200 g	B	-	26	2.1
GALLIFORMES						
Lyrurus tetrix	Black grouse	1.1 kg	B	-	1	-
Perdix perdix	Grey partridge	400 g	B	2	14	1.1
Phasianus colchicus	Pheasant	1.1 kg	B	3	9	0.7
CHARADRIIFORMES						
Haematopus ostralegus	Oystercatcher	500 g	B	2	5	0.4
Vanellus vanellus	Lapwing	215 g	B	6	160	13.0
Charadius hiraticula	Ringed plover	54 g	A	1	1	-
Pluricalis apricaria	Golden plover	185 g	B	1	8	0.6
Gallinago sp	Snipe	125 g	B	-	6	0.5
Scolapax rusticola	Woodcock	304 g	B	-	1	-
Numenius arquata	Curlew	770 g	B	-	5	0.4
Larus sp	Gull	280 g - 1.7 kg	B	23	257	20.9
Larus marinus	Greater black-backed gull	1.8 g	B	-	3	-
Larus fuscus	Lesser black-backed gull	820 g	B	1	12	1.0
Larus argentatus	Herring gull	1.0 kg	B	2	24	1.9
Larus ridibundus	Black-headed gull	275 g	B	1	132	10.0
Larus canus	Common gull	420 g	B	-	20	1.6
Sterna sp	Tern	120 g	B	-	6	0.5
Rissa tridacyla	Kittiwake	390 g	B	-	1	-
COLUMBIFORMES						
Columba sp	Pigeon	up to 465 g	B	3	37	3.0
Columba livia	Rock dove	395 g	B	-	4	-
Columba palumbus	Woodpigeon	465 g	B	-	53	4.3
STRIGIFORMES						
Strix sp	Owl	170 - 380 g	B	-	9	0.7
Athena noctua	Little owl	166 g	B	-	2	-
Bubo bubo	Eagle owl	2.8 kg	C	-	1	-
Asio flammeus	Short eared owl	355 g	B	-	4	-
Strix Aluco	Tawny owl	480 g	B	-	1	-
Tyto alba	Barn owl	315 g	B	-	4	-
APODIFORMES						
Apus apus	Swift	40 g	A	-	43	3.5

PASSERIFORMES

Caprimulegus europaeus	Nightjar	70 g	A	-	1	-
Alauda arvensis	Skylark	40 g	A	-	5	0.4
Hirundo rustica	Swallow	19 g	A	-	88	7.2
Hirundinidae	Swift/swallow	19 - 40 g	A	1	84	6.8
Delichon urbica	House martin	20 g	A	-	11	0.9
Anthus Pratensip	Meadow pipit	18 g	A	-	1	-
Motacilla sp	Wagtail	20 g	A	-	2	-
Sturnus vulgaris	Starling	80 g	A	-	18	1.5
Corvus sp	Crow	up to 530 g	B	-	23	1.9
Pica pica	Magpie	220 g	B	-	4	-
Corvus frugilegus	Rook	430 g	B	-	6	-
Corvus corax	Raven	1.1 kg	B	-	2	-
Turdus sp	Thrush	60 - 120 g	A	-	3	-
Turdus merula	Blackbird	106 g	A	-	6	0.5
Turdus pilarus	Fieldfare	100 g	B	-	1	-
Passeriform	Sparrow	18-40 g	A	-	27	2.2
Passer domesticus	House sparrow	18 g	A	-	6	0.5
Fringilla coelebs	Chaffinch	23 g	A	-	1	-
Carduelis cannabina	Linnet	18 g	A	-	1	-
Emberiza citrinella	Yellow hammer	27 g	A	-	2	-
BAT					1	-
UNKNOWN				38	576	-
TOTAL				92	1803	-

Notes: 4.1 Bird weights and Scientific Names are based on 'Average Weights of Birds' by T Brough of Aviation Bird Unit, Worplesdon Laboratory, Agricultural Science Service, MAFF, Worplesdon, England. The average weight has been assumed.

4.2 The bird Categories based on current Civil Airworthiness requirements are:

A below 110 g (1/4 lb)
B 110 g to 1.81 kg (1/4 lb to 4 lb)
C over 1.81 kg to 3.63 kg (4 lb to 8 lb)
D over 3.63 kg (8 lb)

4.3 Those birds not positively identified are tabled as Unknown, except where there is evidence that they are Large (C or D).

4.4 Percentages are based on incidents where birds are identified.

4.5 Damage data not supplied by Austria, Denmark, France, Ireland and Norway.

TABLE 5 PART OF AIRCRAFT STRUCK - 1983

Part struck	Bird Weights					% Based on 1751
	Unknown	Below 110 gm	110 gm to 1.81 kg	Over 1.81 kg	Total	
Fuselage	100	43	107	1	251	14.3
Nose (excluding radome and windscreen)	141	108	141	1	391	22.3
Radome	89	56	66	-	211	12.0
Windscreen	94	70	100	-	264	15.1
Propeller	1	1	22	-	24	1.4
1 engine struck	90	21	87	1	199	11.4
2 out of 3 struck	-	-	1	-	1	-
2 or more of 4 struck	2	-	6	-	8	0.4
all engines struck	4	1	15	-	20	1.1
Wing/Rotor	84	20	135	-	239	13.6
Landing Gear	20	17	88	1	126	7.2
Empennage	5	2	10	-	17	1.0
Part unknown	49	34	150	-	233	-
TOTAL	679	373	928	4	1,984	100%

Notes: 5.1 The totals in Table 5 are higher than other tables, as several parts can be struck in one incident.

5.2 The percentages are based on incidents where the part struck is known.

5.3 Where both landing gear, or both wings are struck, two incidents are recorded.

5.4 110 gm = 1/4 lb, 1.81 kg = 4 lb, 3.63 kg = 8 lb.

TABLE 6 EFFECT OF STRIKE - 1983

Effect	Bird Weights					Total	% Based on 1852
	Unknown	Below 110 gm	110 gm to 1.81 kg	1.81 kg to 3.63 kg	Over 3.63 kg		
Loss of life/aircraft	-	-	-	-	-	-	-
Flight crew injured	-	-	-	-	-	-	-
Engine repairs on:							
2 engined aircraft	22	2	32	-	-	56	3.0
Others	26	6	34	-	-	66	3.6
Windscreen cracked or broken	1	-	1	-	-	2	-
Vision obscured*	1	-	1	-	-	2	-
Radome changed	6	-	5	-	-	11	0.6
Deformed structure	-	-	3	-	-	3	-
Skin torn/light glass broken	11	1	15	-	-	27	1.5
Skin dented*	6	-	14	-	-	20	1.1
Propeller/Rotor/ transmission damaged	-	-	-	-	-	-	-
Aircraft system lost	1	2	10	-	-	13	0.7
Take off abandoned*	3	-	10	-	-	13	0.7
Nil damage	1,123	159	353	4	-	1,639	88.5
Unknown	46	10	32	1	-	89	-
TOTAL	1,246	180	510	5	-	1,941	100%

Notes: 6.1 If, for example, skin is torn in two places, or both windscreens are broken, two incidents are recorded.

6.2 The percentages are based on known effects.

6.3* Not counted as damaging strikes.

6.4 Aircraft systems lost include hydraulics, pitot and de-icing.

TABLE 7 AIRCRAFT OPERATORS - 1983

(Note: A high strike rate may be due to efficient reporting)

Operator	Number of Strikes	Number of Movements	Strikes Per 10,000 Movements
AUSTRIA			
Austrian Airways	26	54,200	4.8
BELGIUM			
Sabena	26	68,412	3.8
TEA	3	17,472	1.7
CZECHOSLOVAKIA			
CSA	17	46,916	3.6
DENMARK			
Cimber Air	-	7,202	-
Conair	3	5,178	5.8
Maersk Air	17	32,218	5.3
SAS	20	85,716	2.3
Sterling Airways	3	28,066	1.1
FINLAND			
Finnair Oy	47	132,876	3.5
FRANCE			
Air France	132	157,336	8.5
Air Inter	74	290,957	2.5
UTA	6	20,698	2.9
TAT	8	86,084	0.9
IRELAND			
Air Lingus	65	62,582	10.4
Avair	6	-	-
ITALY			
Alitalia	-	157,000	-
Aer Mediterranea	-	43,453	-
NETHERLANDS			
KLM	62	116,290	5.3
NLM	8	58,624	1.4
Transavia	4	9,542	4.2
Martin Air	3	5,101	5.9

NORWAY			
SAS	49	-	-
Braathens SAFE	14	-	-
Wideroe	3	-	-
Helicopter Service	7	-	-
Fred Olsen	1	-	-
Others	3	-	-
SWEDEN			
Linjeflyg AB	34	112,000	3.0
SAS	33	68,482	4.8
Kungs Air	1	994	10.1
SWITZERLAND			
Swissair	164	179,276	9.1
Alisarda	3	-	-
Balair	2	10,410	1.9
UNITED KINGDOM			
Air Atlantique	2	5,646	3.5
Air Bridge Carriers	1	3,822	-
Air Europe	8	22,246	3.6
Air Ecosse	1	6,526	-
Air UK	20	62,394	3.2
Bristow Helicopters	3	46,348 hrs	0.6
British Aerospace	9	-	-
Britannia Airways	91	77,420	11.7
British Air Ferries	3	11,160	2.7
Birmingham Executive	1	2,370	-
British Airways	163	359,878	4.5
British Airways Helicopters	7	29,958 hrs	2.3
British Caledonian Airways	55	84,460	6.5
British Caledonian Helicopters	-	4,270 hrs	-
British Island Airways	-	7,872	-
British Midland Airways	21	72,376	2.9
Brymon Airways	3	12,248	2.4
Channel Express	1	6,074	-
Dan-Air Services	41	98,772	4.1
Ford	3	-	-
Genair (Lease Air)	9	23,790	3.8
Guernsey Airlines	2	4,858	4.1
Heavylift Cargo	1	1,322	-
Instone	-	286	-
Inter City Airlines	1	3,576	-
Janus	5	N/A	-
Loganair	6	7,144	8.4
MAM	3	-	-
Manx Airlines	7	15,512	4.5
McAlpine	1	-	-
Monarch Airlines	7	19,222	3.6
North Scottish Helicopters	-	1,797 hrs	-
Orion Airways	13	20,256	6.4
Peregrine	2	-	-
Tradewinds Airways	-	1,954	-
Private Operators	7	-	-
Unknown	34	-	-
TOTAL (Operators with known movements)	1366	-	-

Notes: 7.1 Leased aircraft are included against the operator.

7.2 Where the number of incidents, or number of movements is small and particularly where they are both small, the derived rate should be treated with caution.

ADF616066

BSCE 18/WP 22
Copenhagen, May 1986

AIR TRAFFIC CONTROL RADAR DATA ANALYSIS AND BIRD MOVEMENTS DETECTION

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Summary

This paper discusses the problem of the analysis of the ATC radar echoes and the possibility of detecting bird's movements, by implementing an appropriate logical function.
The approach looks promising and some additional advantages may be expected in terms of system performances. Moreover, it is suggested that this problem should be duly considered in the specification of the ATC radar meteo channel.

Foreword

This document discusses the analysis of the ATC radar data not caused by aircrafts, the problems involved in their classification aimed to the detection of the bird's movements, and the possible use of such information.

General

Bird's detection by radar is a well known phenomenon, and a wide bibliography is available on the subject. Normally the data are collected with the cooperation of ornythologists and involving a noticeable number of observers. We want examine whether it is possible to implement a permanent function of radar data analysis and reconnaissance.

At the radar output (digital or video) we found, besides the signals caused by aircrafts, other signals, caused by

- surface traffic (terrestrial and marine)
- meteo phenomena
- sea clutter
- other airbone targets (birs, insects and smokes)
- anomalous propagation

In order to characterize the radar environment and to analyze a few simple cases, AAAVTAG and Selenia of Italy have jointly developped an experimental work.

Data collection description

Two different types of sensor have been used: an en route radar (Poggio Lecceta) whose digital signals (plots) have been recorded on disk at the Regional Control Center (CRAV) of Ciampino, and a terminal area radar (Fiumicino) whose video signals have been recorded in TV raster format. The main parametres of the radars are indicated in the appendix A.

The digital data have been processed, obtaining several types of diagrams; the most significant are the position at parametric intervals [XY (nT)] and the coordinate versus scan time [X (T) or Y (T)]. The first diagram show the position of the signals every n antenna scans. This graphical artifice makes easier to recognize the movement, because at such time intervals the steady state component of the motion prevails on the statistical component. A real time approach would require slow tracking techniques, with some arrangements for the signals distributed over several radar cells.

For these elaborations we have used only omogeneous cases, i.e. caracthterized by a single type of sources.

The video signals have been used as a reference either for the digital presentation, either for the visual observation in order to identify the sources. During this phase the Roman Section for the Birds Protection (SRoPU) has actively collaborated, providing information about position, time, quantity and type of flocks. It has been therefore possible to identify on the terminal radar screen the signals caused by birds. It has not been possible to obtain similar identifications on the en route radar due to the distance between the visual observers positions and the area covered by the radar and probably interested by the phenomenon.

Figures 1 thru 6 show the diagram derived from surface traffic (terrestrial and marine) and meteo echoes.

Figures 7 thru 10 show the raw video of the terminal area; it is evident the evolution of the signal that has been positively identified as flock of starlings (sturnus vulgaris) moving toward the breeding area, thanks to the cooperation of the SRoPU. For such a signal the digital translation is similar to that of a meteo nucleus; a more concentrated flock appears more like to a marine target.

Analysis of the results

The analysis of these sample of environment lead us to the following considerations:

1) The different sources are characterized by evolution profiles (in space and time) quite typical, and they are active when certain measurable parametres assume well defined values (pressure, wind, temperature, sea state and similar).

2) The absolute speed is slow (if compared to the air traffic); the spatial distribution of the signals fluctuates more from scan to scan. The processing and display technique used in ATC, which has been optimized for the aircrafts, makes very difficult to recognize the evolution profiles, particularly when different types of sources are active in the same time and area.

3) The sources height is concentrated at medium and low levels, where the radar sensitivity gradient reaches high values. Rven if the sign is favourable (the sensitivity increases toward the levels more interesting for safety) the module is too large.

4) The analysis of the signals needs times longer than the air traffic, it tolerates slower rates, and, by memorizing the previous situations (short and long terms) it allows quick reconnaissance or even prediction for certain types of sources.

Possible applications

This picture allows us to make the following hypotheses about the signal processing:

a) data processing

An automatic analysis function, fed by the primary extractor accumulates results and, in a later stage, supplies the extractor with information useful to reduce the processing load of the same extractor. The typical case is the ground traffic, where the automatic function is able, in the long run, to supply the matrix of all the possible coordinates. The automatic function therefore, besides to supply the inforamtion about the sources to the control center, increases the actual load capabality of the system and its available sensitivity. The final configuration foreseen the automatic function embedded in the extractor, due to the amount of integration with it and with the radar; as an interim solution it can be implemented on separated machine working in parallel with the extractor.

The availability of the doppler measurement, expected at short terms, will increase the analysis capabilities.

We must emphasize that the above is applicable either to the en route, either to the terminal area radars. For these, normally sited inside the airport area, the increase of acceptable load offered by the automatic function is extremely important because it allows to watch the close in zone.
It is foreseen that the surveillance of local birds movements will be available, possibly with a suitable integration with the airport surface movement radar system.

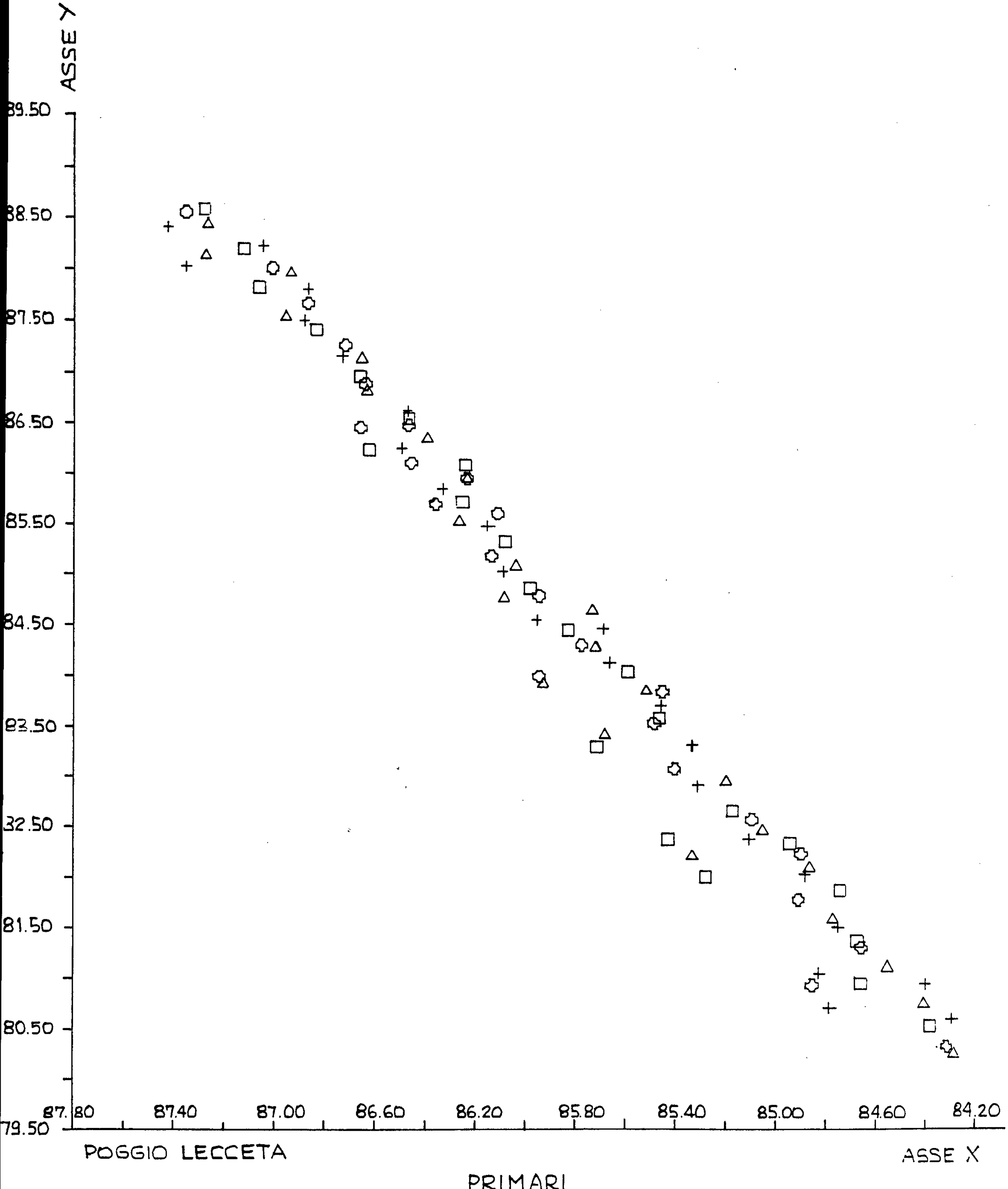
b) Effect on the radar configuration

The problems that we have discussed so far have an high degree of commonality with the processing of the metereological signals in the Air Traffic Control Radars. If we exclude some peculiar problems of normalization and level quantization, the analysis and the reconnaissance of meteo echoes require the same processing that we have envisaged in our case. It is therefore logical to imagine a dedicated receiving channel that encompasses also the meteo function, and is handled by the automatic reconnaissance function. In this case it is possible to perform also sensitivity tests, changing the radar parameters on a scan to scan basis. The automatic function is therefore strongly powered, and it may resolve a number of ambiguities that cannot be resolved at plot level, or at least using more time.

A few words about the use of the signals

When the sensor is equipped with the automatic function, a map of signals, where only airbone sources are present with ambiguity not exceeding two, is available. This map may be transmitted using low speed channels, and it may include also information about the radar setting, and therefore on the expected coverage. This type of message may use the same transmission medium, and probably the same gestional structure of the system telediagnostic. In the Control Center the maps can be composed together (a mosaic is probably sufficient), correlated with the meteo information, and therefore cleared from the remaining ambiguities. The image synthesized in this way, having resolved all the reconnaissance problems, is an essential support tool for an human operator.

/gp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POGGIO LECCETA
ASSE X
PRIMARI

FIG. 1

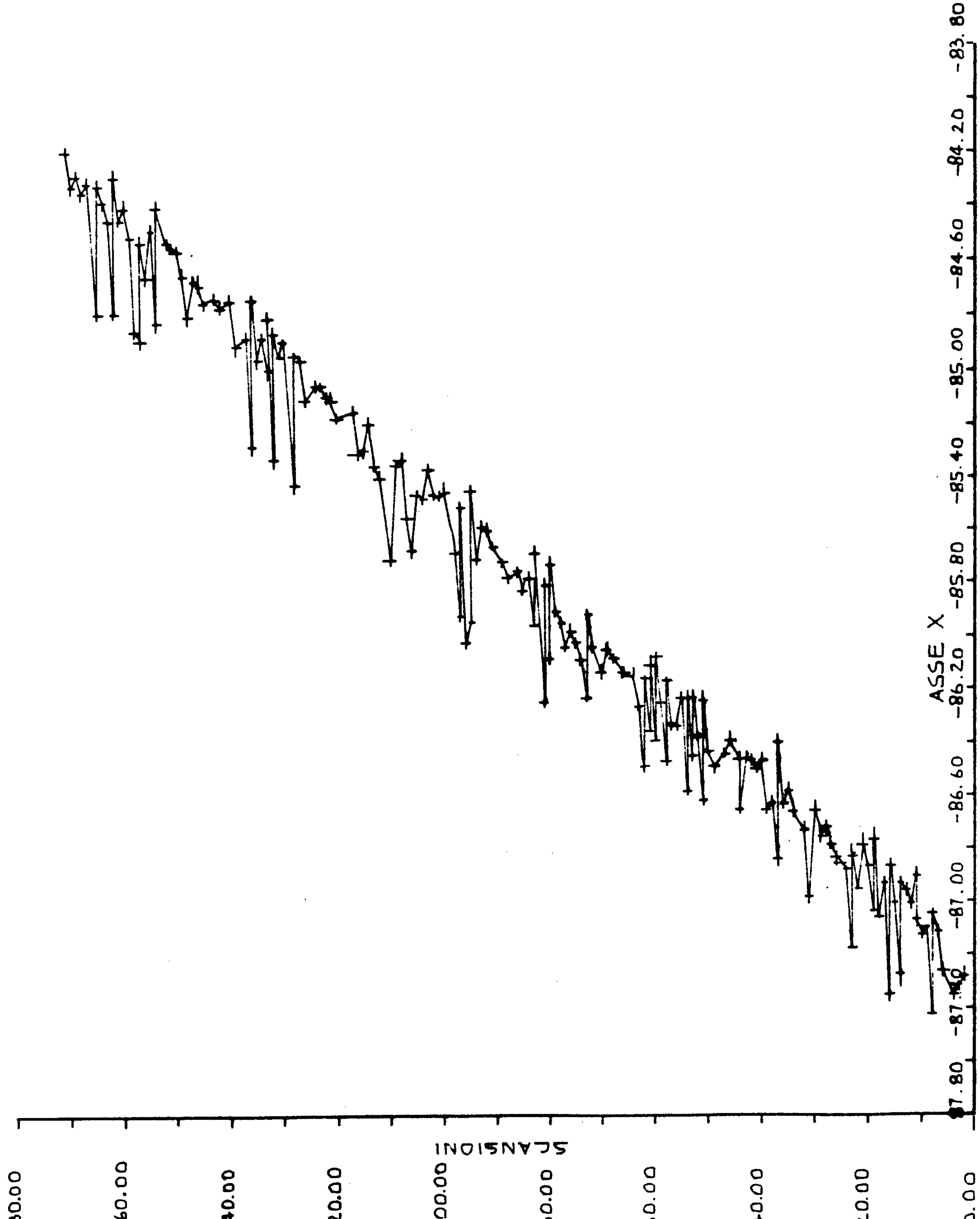
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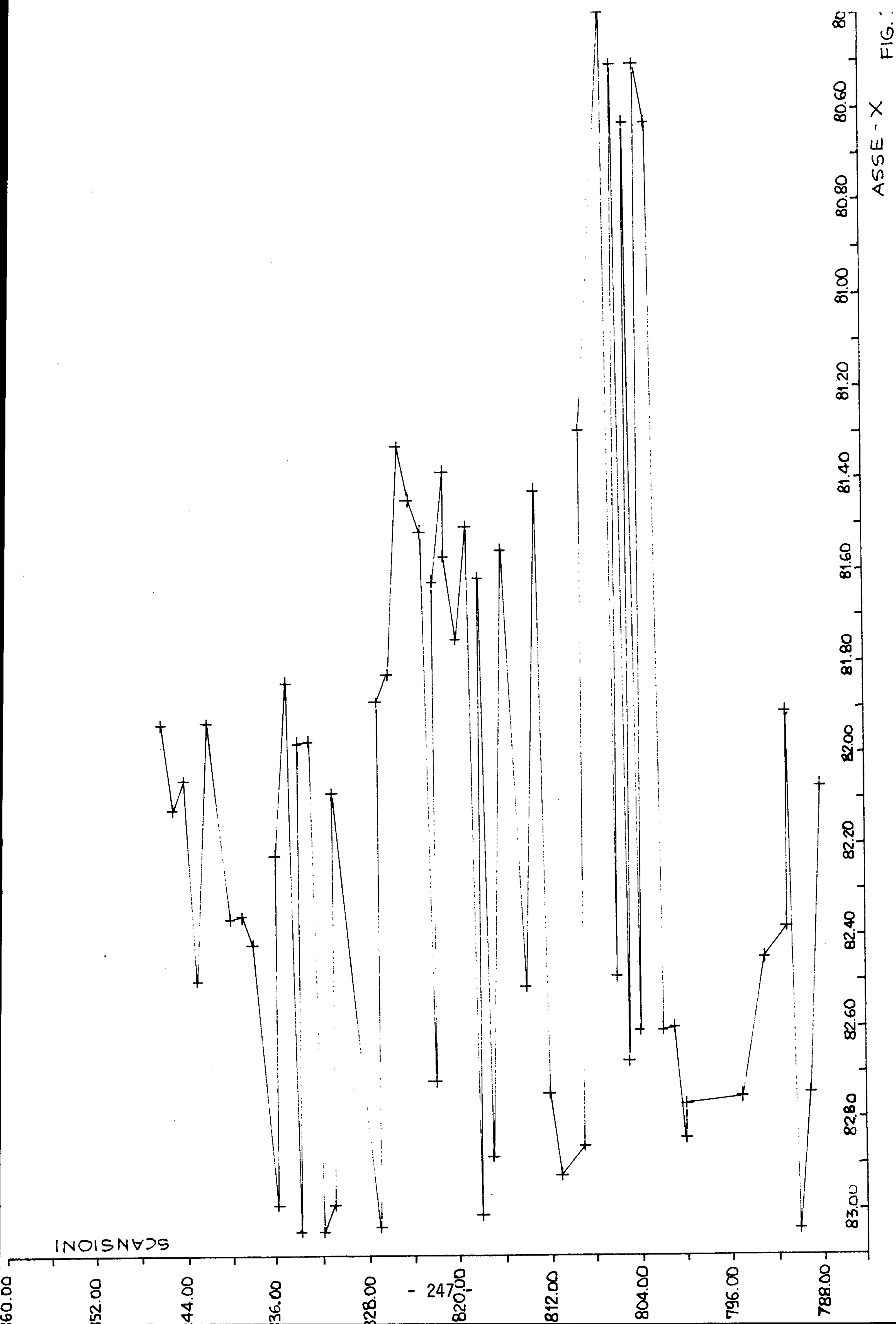
FIG. 2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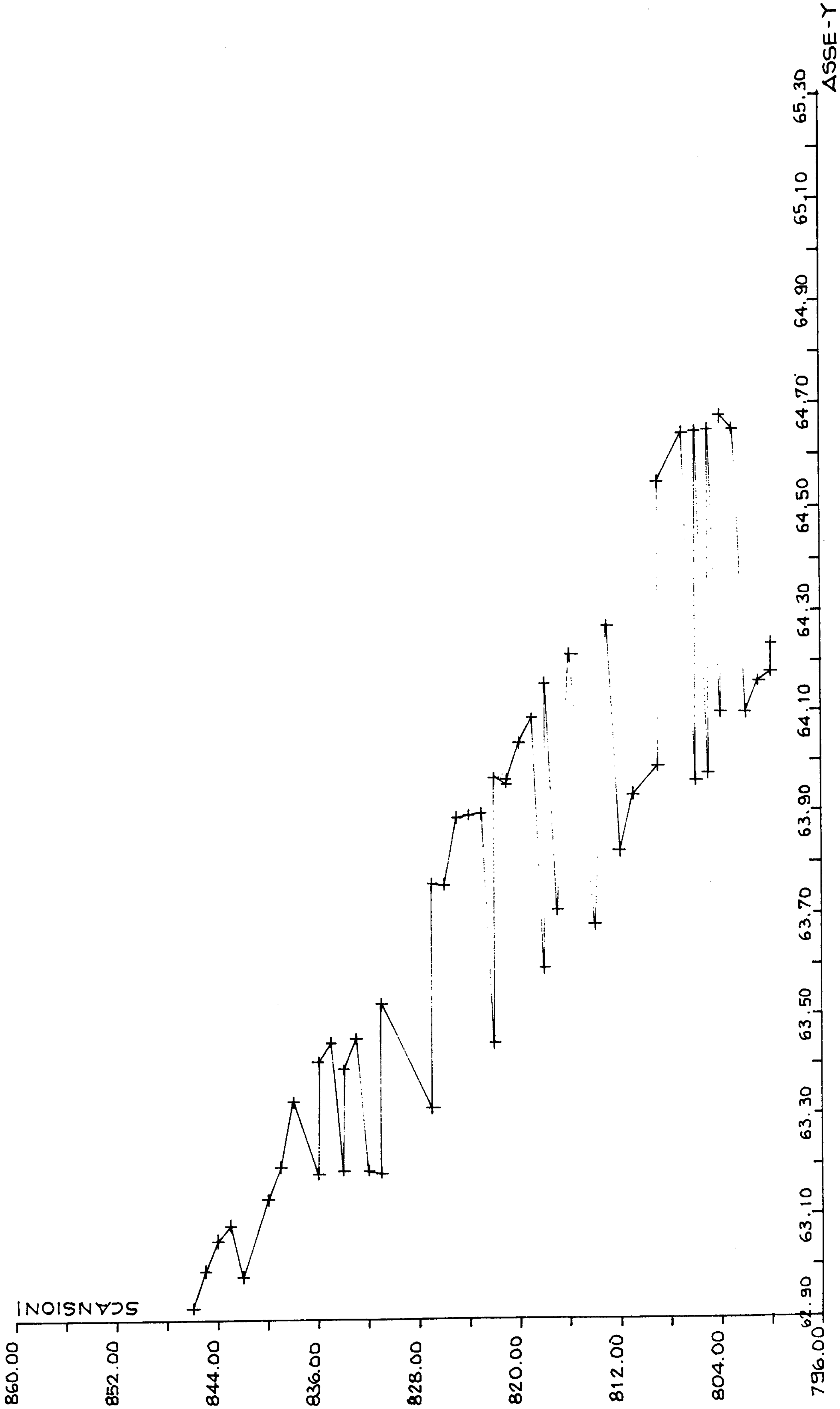
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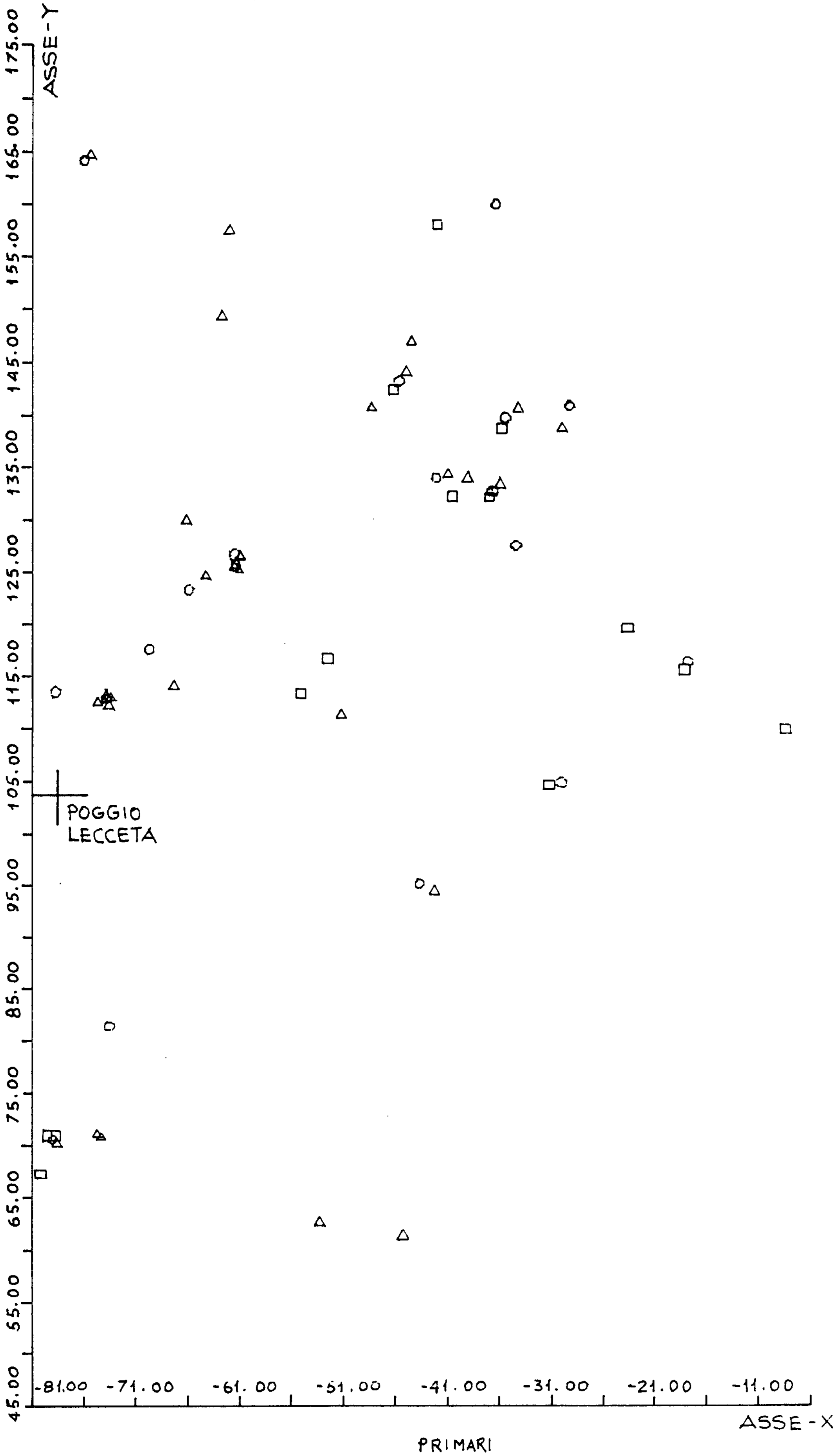
FIG. 4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POGGIO
LECCETA
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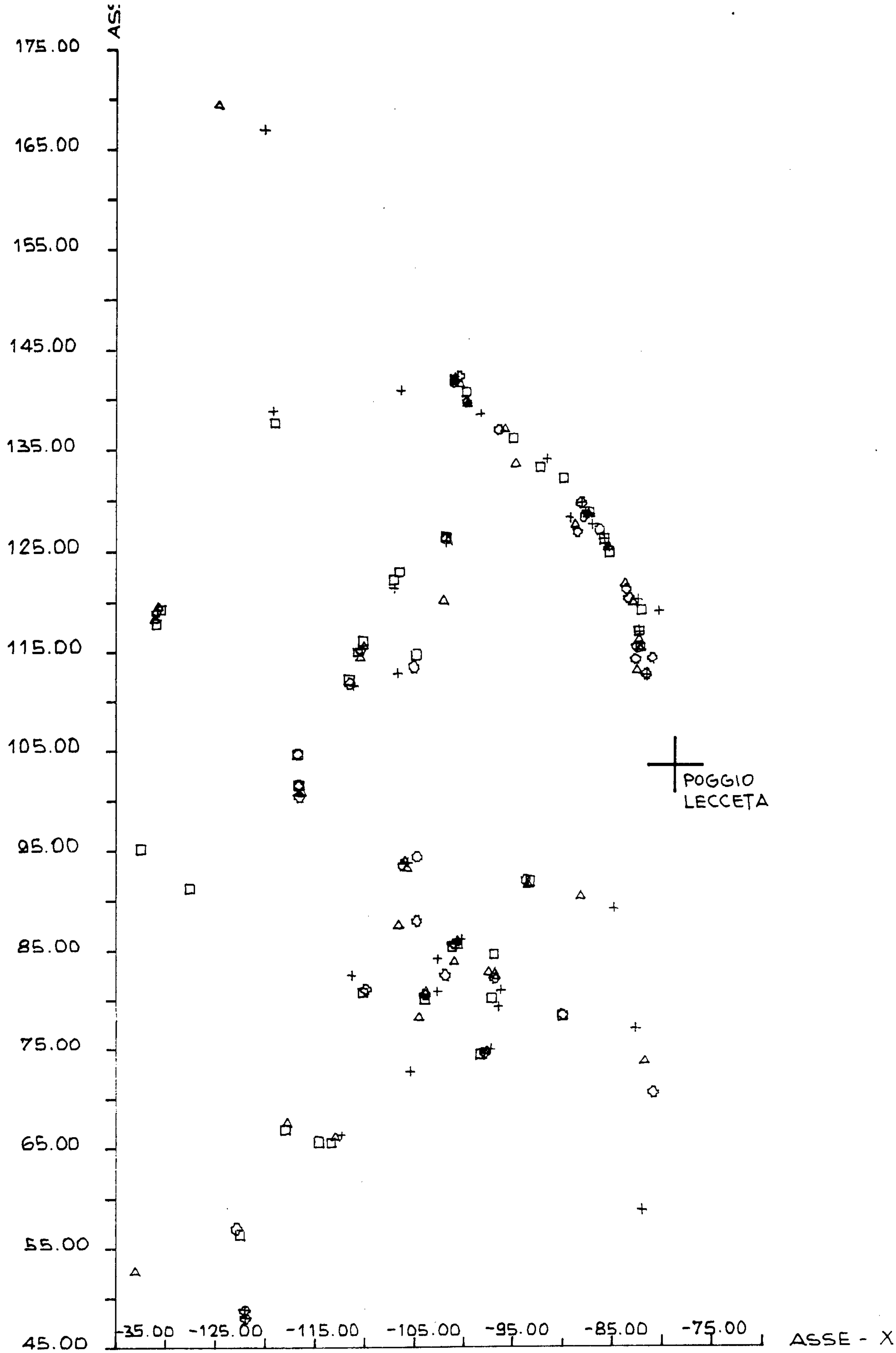
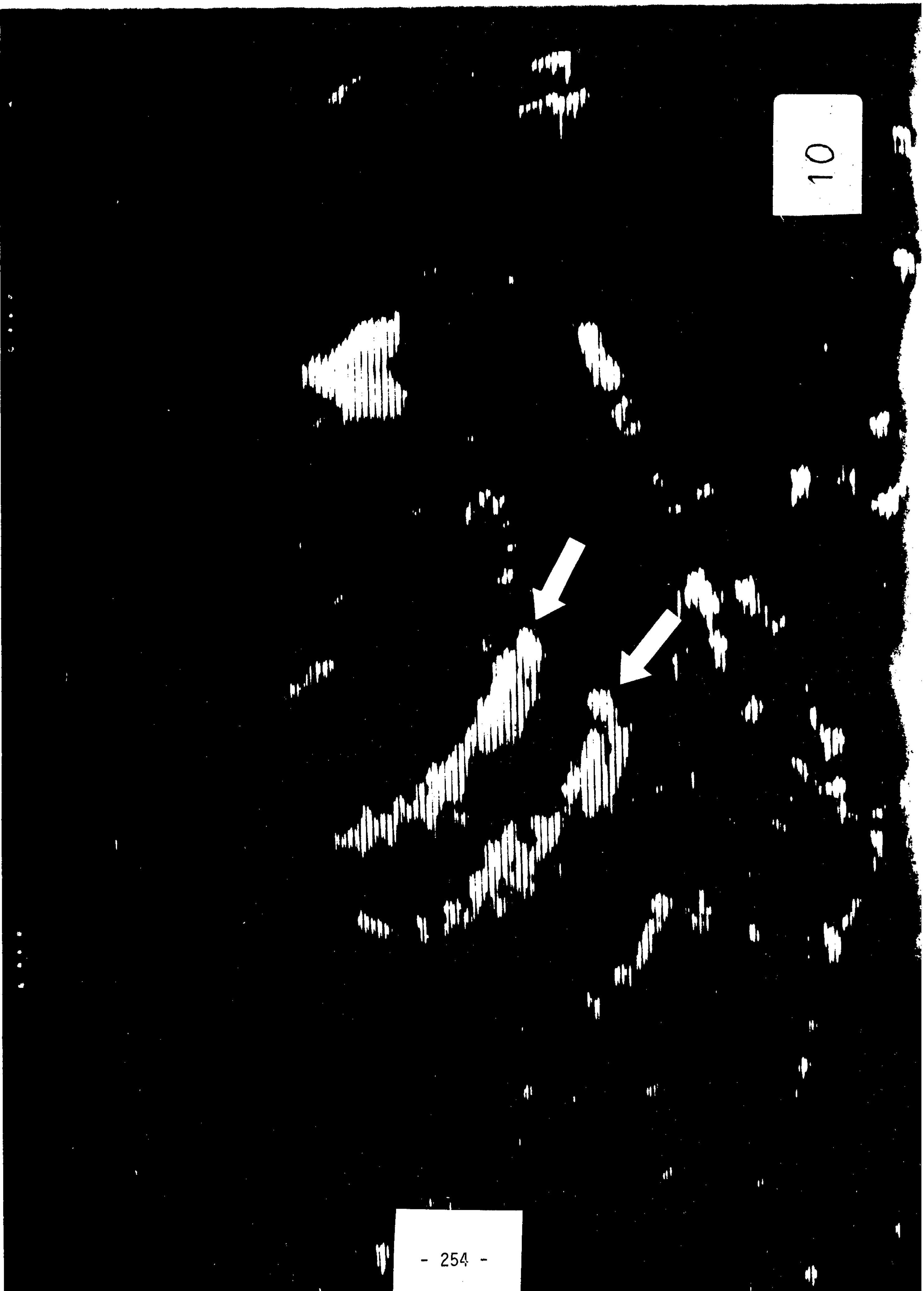
FIG. 5



PRIMARI

FIG. 6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ADF616067

BSCE 18/WP 23
Copenhagen, May 1986

Identification of bird remains for bird strike analysis: a literature synopsis.

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INTRODUCTION

At the meeting of the Analysis Working Group during BSCE 17 in Rome, discussions of the work on the analysis of feather remains showed that there was a need for the formation of a sub-group to deal with this specialised area. The main goal of this sub-group is to pursue the work on the identification of bird remains, with emphasis on the microscopic structure of feather remains.

This paper intends to provide an introduction to relevant literature (including abstracts) in order to make knowledge and techniques for the identification of bird remains more accessible for those who are interested in this field of research and who wish to refine their identification methods.

Publications featuring the research on identification of bird remains can be roughly summarized into five categories:

1) Papers dealing with basic research of feathers.
2) Papers denoting the need for proper identification of bird remains.
3) Papers using the results of microscopic identification of feather remains.
4) Papers on identification methods for complete bird bodies or big parts, such as bills, feet, wings, tail and skeletal
5) Papers on biochemical identification methods for blood, amino-acids, etc.

LITERATURE SYNOPSIS

1. Papers dealing with basic research of feathers.

Brom, T.G. & L.S. Buurma 1979. The quality of identification: a microscopic key to the determination of feather-remains. 14th Meeting BSCE (The Hague), working paper 19: 1-6.

Principles of identifying feathers by studying the microstructure of downy barbules are explained (and were illustrated with slides during the meeting) and the influence of careful analysis on bird strike statistics is briefly discussed.

Brom, T.G. 1980. Microscopic identification of feather remains after collisions between birds and aircraft (Amsterdam): 1-89 (out of print).

A reference collection of more than two thousand feather preparations (a number of which are presented as photographs), from some 350 species of birds was made. Microscopic examination reveals taxonomic differences in the structure of downy barbules relating to number of prongs, number, shape, position and size of nodes. An identification key is compiled which can be used for bird strike analysis.

Brom, T.G. 1986. Microscopic identification of feathers and feather fragments of palearctic birds. Bijdr. Dierk. 56 (2) (in press).

An updated version of the report mentioned above (with 48 photographs).

Chandler, A.C. 1916. A study of the structure of feathers, with reference to their taxonomic significance. Univ. Cal. Publs. Zool. 13: 243-446.

An extensive study of the structure of pennaceous feathers of North American birds that reveals large differences between different groups of birds. From a few species also the downy barbules were studied and evidence is provided that the structure of these barbules is of diagnostic value.

Day, M.G. 1966. Identification of hair and feather remains in the gut and faeces of stoats and weasels. J. Zool. 148: 201-217.

Qualitative analysis of prey remains collected from small carnivores depends on being able to identify feather (and hair) fragments. Feather identification is based on the structural variations to the downy barbules of feathers. A key to the main bird orders is devised.

Laybourne, R.C. 1984. Identification of bird remains from bird-aircraft incidents by the microstructure of the downy part of the feather. Proc. 17th Meeting BSCE (Rome): 282-286.

The principles of identifying feathers by studying the microstructure of downy barbules are explained (and were illustrated with slides during the meeting).

Laybourne, R.C. 1986. The variation of the nodal structures on downy barbules of some species of birds. This BSCE Meeting.

Slides of scanning electron microscope (SEM) photographs were presented illustrating the variation of nodal structures in Wood Pigeon, American Kestrel, Gyrfalcon, Double-crested Cormorant, Mute Swan, Whistling Swan, Greylag Goose, Brant, Mallard, Pied-billed Grebe, and Northern Oriole.

Robertson, J., C. Harkin & J. Govan 1984. The identification of bird feathers. Scheme for feather identification. J. forensic Sci. Soc. 24: 85-98.

The structure of downy barbules is reviewed. Features of the feathers are selected giving discrimination at order level. Quantitative data are presented.

2. Papers denoting the need for proper identification of bird remains.

Brom, T.G. & L.S. Buurma 1981. Microscopische herkenning van veerresten: hulpmiddel bij de analyse van aanvaringen tussen vliegtuigen en vogels. Het Vogeljaar 29 (1): 9-17.

The effect of microscopic identification of feather remains on RNLAF bird strike statistics is described. Photographs of bird remains and feather preparations are included (in Dutch).

Brom, T.G. 1984. Microscopic identification of feathers in order to improve birdstrike statistics. Proc. Conf. Wildlife Hazards to Aircraft (Charleston, S.C.), report no. DOT/FAA/AAS/84-1: 107-120.

The influence of microscopic feather identification on RNLAF bird strike statistics is demonstrated by comparing identification results obtained by the macroscopic method of comparing feathers with bird skins, with those obtained by the microscopic investigation of feathers. Identification results from 1960-1977 are compared with those from 1978-1983, and the effect of the introduction of the identification key on bird strike statistics is discussed.

Buurma, L.S. & T.G. Brom 1979. The quality of identification: its effects on birdstrike statistics. 14th Meeting BSCE (The Hague), working paper 20: 1-8.

The risk of overrepresentation in bird strike statistics of easily recognizable birds (e.g. big and white ones) and more or less intact bird corpses (that can be collected easily) is evaluated. The study of the microstructure of feathers as a method to avoid this type of bias in bird strike analysis is discussed.

Buurma, L.S. & T.G. Brom 1980. Harde feiten over zachte veren. Veilig Vliegen 27 (1); 9-13 (this article also appeared in Technisch Informatie Programma (KLM) 9 (92): 14-16).

The effect of microscopic identification of feather remains on RNLAF bird strike statistics is described (in Dutch).

Buurma, L.S. 1982. Birdweight and aircraftspeed in birdstrike statistics. 16th Meeting BSCE (Moscow), working paper 17: 1-6.

Microscopic analysis of even the smallest and most distorted feather remains highly improved RNLAF bird strike statistics. Some types of bias as over-representation of 'airfield bird species' and under-representation of small birds struck 'en route' are discussed.

Buurma, L.S. 1983. Increasing birdstrike rates and improved birdstrike analysis of the Royal Netherlands Air Force. Paper presented at the Conference on Aerospace Transparent Materials and Enclosures (Scottsdale, Ar.): 1-25.

The primary aim of this paper is to show why bird strike statistics to a varying extent fail to produce a realistic picture of the bird strike risk. Several types of bias are described. Problems can be reduced by improving reporting standard and by taking microscopic examination of miniscule bird remains as a routine procedure.

Thompson, M.M., R.P. DeFusco & T.J. Will 1986. U.S. Air Force bird strikes. This BSCE Meeting, working paper 8, 11 pp.

The importance of positively identifying birds which are involved in collisions with aircraft cannot be overemphasiszed, because only then can realistic reduction measures be taken. In the past few years, increased emphasis on post-strike feather identification has provided a much more accurate picture of which birds to concentrate control efforts on.

3. Papers using the results of microscopic identification of feather remains.

Buurma, L.S., A. Dekker & T.G. Brom 1984. On the spatial and temporal distribution of bird species involved in RNLAF bird strikes. Proc. 17th Meeting BSCE (Rome): 212-226.

Results of the analysis of RNLAF bird strikes are summarised, with special reference to the temporal and spatial variation in the contribution of different bird categories and species. Proper identification procedures, to start with microscopic examination of feather remains, appears to be a prime prerequisite. Especially the seasonal fluctuations of ratios examplified for collisions "above airbases" and "en route" respectively show how many details can be extracted from a relatively small data base.

Davies, A. 1970. Micromorphology of feathers using the scanning electron microscope. J. forensic Sci. Soc. 10 (3): 165-174.

An account of the work done as a result of a case of bird larceny being brought to the Metropolitan Police Forensic Science Laboratory.

Deedrick, D.W. & J.P. Mullery 1981. Feathers are not lightweight evidence. FBI Law Enforcement Bulletin (September 1981): 22-23.

Microscopic feather identification as forensic tool. Feather-related examinations are made in cases of rape, homicide, burglary, bird strikes, and even a hoax bombing.

Gilbert, F.F. & E.G. Nancekivell 1982. Food habits of mink (Mustela vison) and otter (Lutra canadensis) in northeastern Alberta. Can. J. Zool. 60: 1282-1288.

Scats of mink and otter were studied. Feather remains were identified using Chandler (1916) and a reference collection.

Hargrave, L.L. 1965. Identification of feather fragments by microstudies. American Antiquity 31 (2): 202-205.

One investigator, trained in the technique of feather identification, was tested intensively to determine the accuracy of his identifications.

Messinger, N.G. 1965. Methods used for identification of feather remains from Wetherill Mesa. American Antiquity 31 (2): 206-215.

Feathers provided by archaeologists were examined under a microscope. Trial-and-error comparisons were made until the characters of the unknown species matched those of a known species.

Olsen, A.R. 1981. Distinguishing common food-contaminating bat hairs from certain feather barbules. J. Assoc. Off. Anal. Chem. 64 (4): 786-791.

In order to analyse food samples, differences are described between bat hairs and similar-appearing downy barbules of passeriform birds. Feather identification mainly based on the work of Day (1966).

4. <u>Papers on identification methods for complete bird bodies or big parts, such as bills, feet, wings, tail and skeletal</u>.

Besides the many ornithological handbooks and field guides available, the following study is of particular interest:

Hansen, W & H. Oelke 1973-1983. Bestimmungsbuch fur Rupfungen und Mauserfedern. Beitr. Naturk. Niedersachsens 26 (1973): 25-51, 27 (1974): 2-54, 29 (1976): 85-160, 31 (1978) 53-128, 36 (1983) 1-52.

Extensive study on measurements and patterns of tail-feathers of European birds (with many illustrations) (in German).

5. <u>Papers on biochemical identification methods for blood, amino-acids, etc</u>.

Bont, A. de, J.F. Boomans, P. de Raeve, E. Hoet & B. Verachtert 1986. Strategies for the identification of bird remains from birdstrikes. Survey and advanced approach by biochemical analysis of tissues. This BSCE Meeting, working paper 12, 10 pp.

Several biochemical techniques for analyzing bird strike remains are discussed (with their main advantages and drawbacks): thin layer/paperchromatography, gas chromatography, electrophoresis, SDS electrophoresis, isoelectric focusing, and immunological methods. Although none of these methods can be applied in bird strike analysis as a routine, the most promising seem electrophoresis techniques.

LaHam, Q.N. 1967. Report on aircraft turbine engine birdstrike investigations. National Research Council of Canada, Associate Committee on bird hazards to aircraft, Field Note 43: 1-27.

Microscopic investigation of scrapings collected from engines combined with the use of amino-acid analysis of protein residues leads to the diagnosis of bird strikes. In this way, defective engines rapidly can be separated into those due to bird strikes and those due to mechanical failure.

ADF616068

BSCE 18/WP 24

Copenhagen May 1986

A GRANULATED INSECTICIDE TO CONTROL
INVERTEBRATES ON AIRFIELDS

by T.A. Caithness, Wildlife Service, Internal
Affairs Department, Private Bag, Wellington,
New Zealand

The broad spectrum insecticide "Thiodan" has been formulated into a high density, slow release, clay-based granule for the control of invertebrates, earthworms in particular, on airfields.

Using the South Island pied oystercatcher, Haematopus ostralegus finschi as the indicator species, the "Thiodan" granule was applied to the 90 hectares of grassed areas at Nelson Airfield in three separate applications: 1983, 1984 and 1985. A marked reduction in feeding attempts and use of the airfield by oystercatchers has resulted, brought about by a huge reduction in earthworms.

A GRANULATED INSECTICIDE TO CONTROL INVERTEBRATES ON AIRFIELDS

T.A. Caithness, Wildlife Service, Internal Affairs Department, Private Bag, Wellington, New Zealand

INTRODUCTION

The large expanses of grassed areas common on airfields world-wide are usually synonomous with high densities of invertebrates and the insectivorous birds which feed on them. To combat this, insecticides have been used widely.

Most invertebrates have regular annual cycles and for only part of their life cycles are they available as food for birds. Earthworms, however, especially in temperate climates, are ever-present and have long been recognised as favoured food for the majority of insectivorous bird species.

In New Zealand, over the years, we have regularly used on airfields the broad spectrum insecticide "Thiodan" - common name Endosulfan, with earthworms being the principal target species. Rarely, though, have we recorded a significant reduction in invertebrates or in bird numbers.

The regular failure on airfields of this chemical (the most effective known for earthworms), which has proven benefits in agriculture and turf culture, can probably be attributed to the differing management of the various swards.

In agriculture, pastures are regularly ploughed up, with crops rotated before being resown in grass. The sward and soil are also often agitated by cloven-hooved animals. Here, then, the soil is kept friable and generally well drained to the stage that agricultural chemicals can penetrate and affect the target species.

In turf-culture i.e. on putting and bowling greens, the turf is managed to a highly technical degree. Greens are cored and scarified regularly to reduce root thatch and hence have good drainage. The humus layer is minimal as all clippings are removed, with the vegetation thrift being maintained by fertilizers. Greens generally have a ph in the order of 6.5 - 7.0, more or less neutral. Despite this management, good greens still support earthworms, which are then controlled. Greenkeepers apply chemicals at the optimum time and hence have few failures. Agricultural contractors, on the otherhand, generally carry out a task when weather conditions permit, regardless of recently past or forecasted climatic conditions. This could well be a further contributory factor in the failure of our efforts so far to control airfield faunas.

The principal problem, though, is that on many airfields the grassed areas may be decades old, with the only management being regular mowing to keep them neat and tidy. Characteristically then, airfield swards lack vigour and they develop a matted thatch of roots and detritis and are often poorly drained. In these circumstances, conventional agricultural chemicals applied as an

emulsion (spray) are held up on the plants or their root thatch. Ultimately, the chemicals lose their insecticidal efficiency by rainwater dilution or U.V. light before contacting the target species.

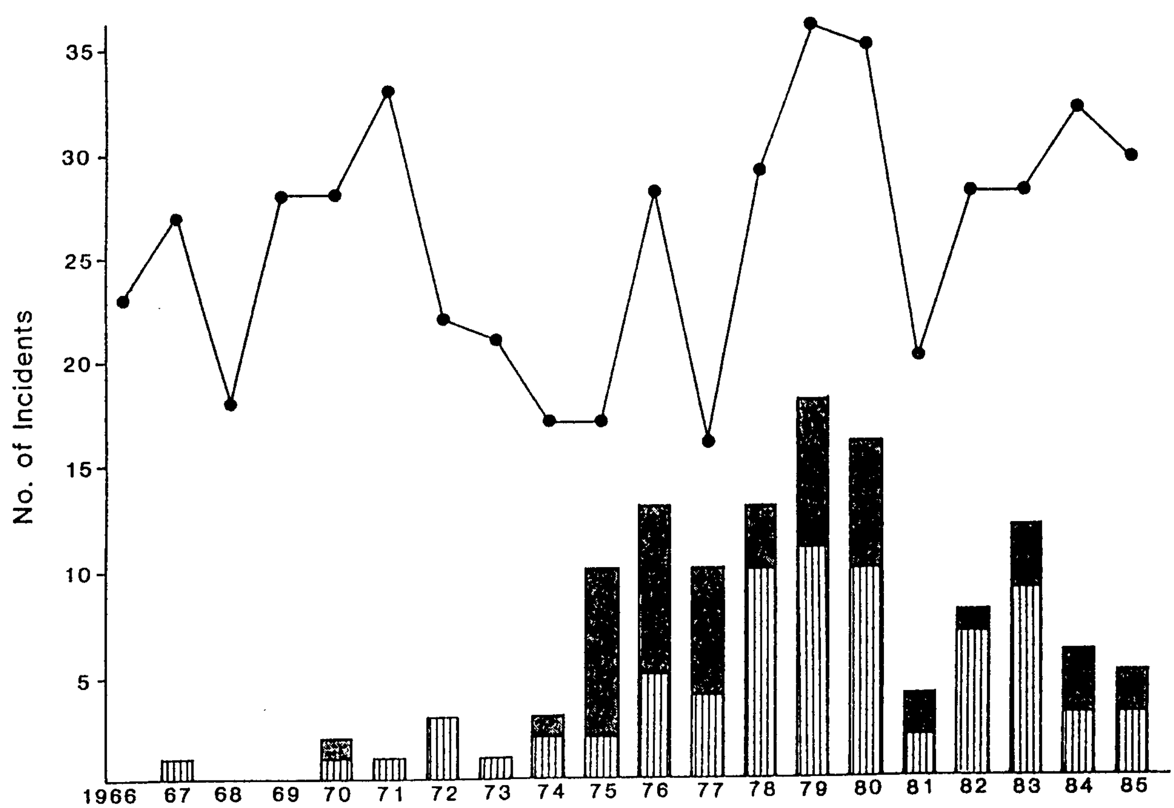
I have been working on the theory that a clay-based, slow release, high density granule, while not achieving a similar soil/plant coverage to sprays, would have the advantage of releasing the toxins more slowly and are very much less prone to degrade with climatic vagaries.

After protracted negotiations, the Fruitgrowers Chemical Company Ltd, Port Mapua, Nelson, agreed to formulate 500 kg of "Thiodan" 10% W/W granules, size range 14.30 BSS, for experimental use at Nelson Airport, a major domestic airfield. Nelson airfield receives in the order of 16,000 aircraft movements each year. These are dominated by turbo-prop passenger aircraft, aero club flights and commuter-third level operators, in that order.

Nelson was chosen for the experimental studies as it has for two decades supported large numbers of South Island pied oystercatchers, Haematopus ostralegus finschi. Here, the airfield earthworms have provided a reliable supplementary high tide food source.

Incidents with all species of birds at Nelson have averaged 26 per year and ranged from a low of 16 to a high of 36 over the last two decades (Figure 1).

Fig 1. All Bird Incidents ● and Oystercatcher Strikes ■ and Near Misses ▥ 1966–1985

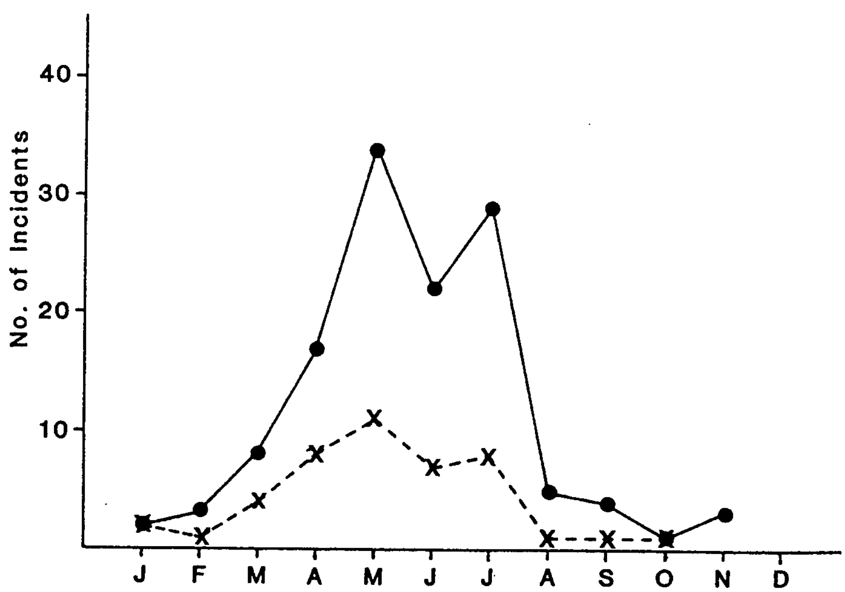


Oystercatchers were of little consequence until the mid-1970's, but have been the major on-field problem since.

The oystercatchers are largely absent throughout Spring and early Summer, being engaged with breeding duties elsewhere. The adults and their young start to return in mid-Summer and build up to a local peak by May. The data in Figure 2 shows the distribution and total number of oystercatcher incidents and the proportion (34%) of them that are strikes through the seasons.

Fig 2. Oystercatcher Incidents ● and Strikes X

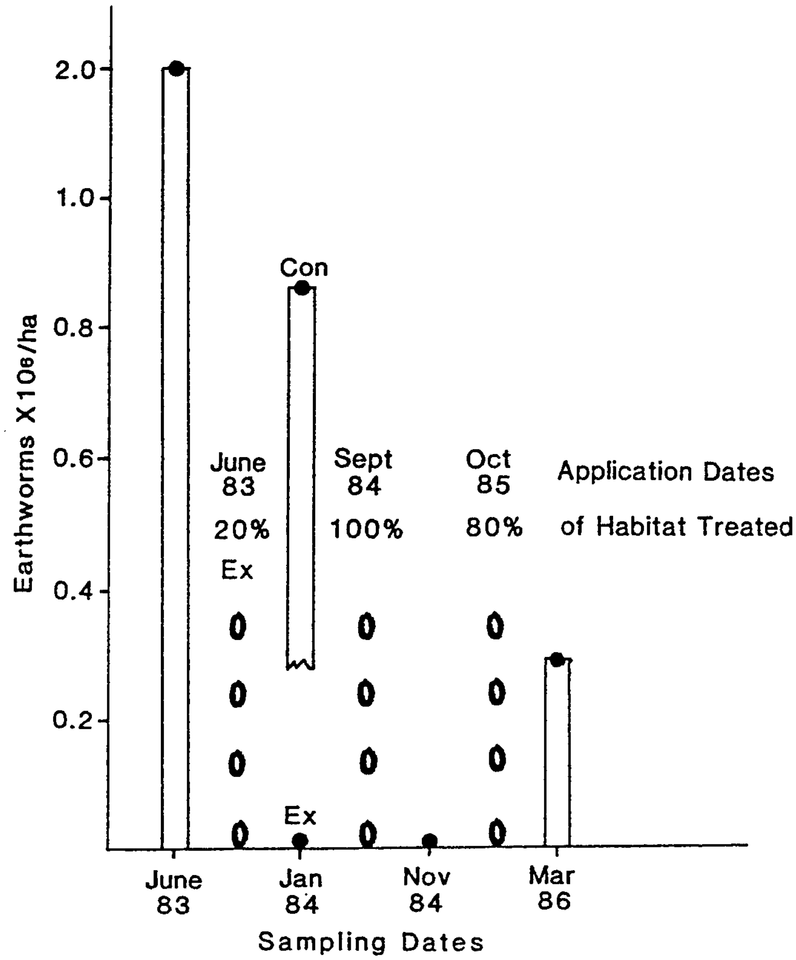
by Month for June 1965 - March 1986



METHODS

"Thiodan" granules were applied at rates varying from 15-45 kg/ha to 20% of the available habitat in June 1983 (Figure 3). In September 1984 the total habitat was treated at 10 kg/ha and in October 1985 a repeat treatment at similar rates to 80% of the area was carried out.

Fig 3. The Effect of Thiodan Granule Applications on Earthworm Numbers



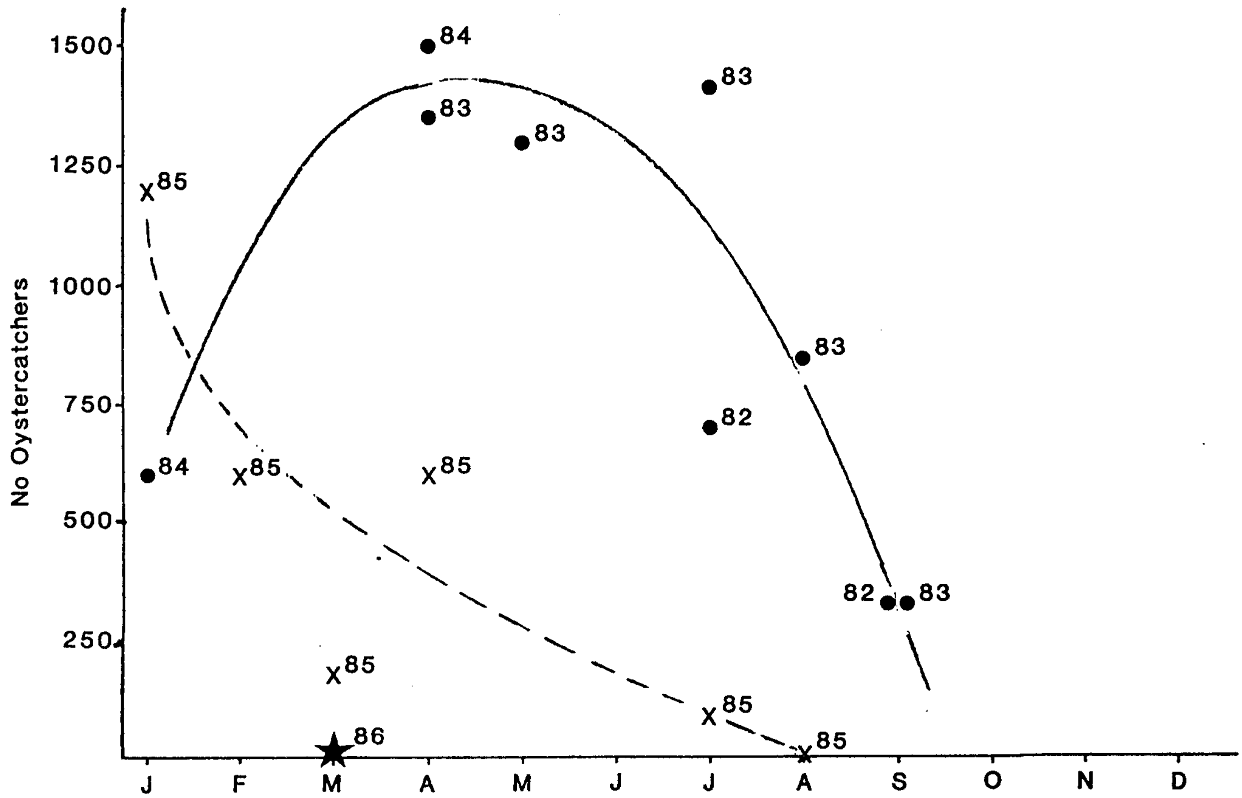
RESULTS

A pre-granule application survey of earthworm numbers in June 1983 revealed a general density of 2 million/hectare (Figure 3). Following the initial experimental treatment in June 1983, earthworm numbers were checked in January 1984. Here, worms were absent in the experimental area, but remained at 860,000/ha in the control or untreated areas. A further worm survey in November 1984 followed the full treatment in September, and showed a complete absence of mature worms, but some earthworm eggs and newly-hatched worms were present. For this reason, the granule was reapplied in mid-Spring 1985 to 80% of the airfield. A soil survey in March 1986 on part of the airfield where oystercatchers were persisting in feeding, revealed the presence of mature worms at 290,000/ha. This confirmed the high mobility of earthworms and their ability to recolonise an area rapidly if untouched populations are nearby. Here, we had not been able to treat a stand of lucerne-Alphalpha-abutting the treated area.

Despite this set-back, there is no doubt that the Thiodan granules had a profound effect on the overall presence of earthworms and an

equally profound influence on the use of the airfield by oystercatchers. Data in Figure 4 show the numbers of oystercatchers using the airfield in the 1982/84 pretreatment period compared with their numbers post-treatment. This is a highly satisfactory result.

Fig 4. Shows the Numbers of Oystercatchers Pre ● and Post X Treatment with Thiodan



Following this work, the Pesticides Board of New Zealand in April 1986 has accepted in principle registration of the "Thiodan" granule which will be marketed under the novel name of "No-Strike", with the registration Number of 3610.

"No-Strike" is marketed by Hoechst New Zealand Limited, 21-39 Jellicoe Road, Panmure, CPO Box 67, Auckland 1, New Zealand. The product is formulated by Fruitgrowers Chemical Company Limited, Port Mapua, Nelson, New Zealand.

ACKNOWLEDGEMENTS

I wish to thank the Fruitgrowers Chemical Company and in particular, Jim McLaughlin and Sheldon Brice for their interest and encouragement after years of frustration in getting the "No-Strike" granule produced. I also wish to thank Air New Zealand and the Civil Aviation Division of the Ministry of Transport for their financial support which has enabled me to present this paper. Finally, thanks to Jo Anastasiadis for her field and technical assistance and for preparing the figures.

ADP616069

BSCE 18/WP 25
Copenhagen, May 1986

AGENDA FOR THE PLENARY MEETING
ON THURSDAY 29 MAY 1986 AND FRIDAY 30 MAY 1986
AT 0900 A.M. BOTH DAYS

1. **Opening by the chairman.**

2. **Presentation of papers:**

2.1	Reduction of Wild Life Hazards to Aircraft	Thurlow and Solman (Canada)	WP/10
2.2	Helicopter Bird Strike Resistance	A. Brémond (France)	WP/14
2.3	Serious Bird Strikes to Civil Aircraft 1984 and 1985	J. Thorpe (UK)	WP/4
2.4	Ethological Aspects of Planes Against Birds	V.E. Jacoby (USSR)	WP/15
2.5	Bird Observation System SEMMER ZAKE	G. Dupont (Belgium)	WP/16
2.6	BSCE Index of Information	L.-O. Turesson (Sweden)	WP/26

3. **Reports by the chairmen of the working groups:**

3.1 Working Group Aerodrome
(Chairman: H. Helkamo, Finland).

3.2 Working Group Analysis
(Chairman: J. Thorpe, UK).

Sub-group on Further Identification
Rapporteur: Roxie Laybourne

3.3 Working Group Bird Movement
(Chairman: J. Hild, FRG).

3.4 Working Group Communication and Flight Procedures
(Chairman: V. Ferry, France).

3.5 Working Group Radar and Other Sensors
(Chairman: B. Bruderer, Switzerland).

3.6 Working Group Structual Testing of Airframes
(Chairman: P. Chalot, France).

3.7 Sub-group on Low-Level Military Aircraft
(Rapporteur: E. Schneider, Denmark).

4. **Cooperation with ICAO:**

4.1 Harmonization of ICAO Documentation on Bird Hazards.

4.2 Actual Status of the ICAO Bird Strike Information System.

4.3 ICAO Workshops on Bird Hazards to Aircraft.

4.4 Other Cooperation with ICAO.

5. **Cooperation with other international organizations:**

5.1 EEC Concil Directive on Bird Conservation.
Actual status of the implementation.

5.2 Cooperation with ECAC.

5.3 Cooperation with IATA and other Organizations.

6. **Elections.**

7. **The Mike Kuhring Award:**

7.1 Presentation of the 4th, 5th and 6th Award.

7.2 Proposal for the 7th Award.

8. **Planning for future meetings of BSCE:**

8.1 BSCE 20, planned to be held in the spring of 1988 in Spain.

8.2 Preliminary planning of BSCE 21, spring 1990 in Finland.

9. **Other matters.**

10. **Termination of the meeting.**

Index for data base. BSCE papers and documents

L-O Turesson Sweden

Summary

According to decisions at BSCE 16 and 17 an index for data base concerning material within the sphere of interest of BSCE has been prepared. As the total possible material is very comprehensive the task has been reduced in this first edition to papers contained into the reports from the first eighteen meetings of BSCE. It's the hope of the author that it will be possible in the future to enlarge the document to include also other papers, books and audiovisual means so that the benefit of it will become even greater.

Background

The idea to develop a specific data base for all types of works concerning the bird problems of aviation came up already some time before BSCE 17 in Rome and was brought forward by me in a paper with the title "BSCE data bank. Proposal for an implementation". The matter had also been discussed within the Steering Committee of BSCE and I had started the task with the distribution of a questionnaire to all National Committees asking mainly fo opinions about the contents of such a data bank: books and booklets, BSCE and other working papers, films and other audiovisual means etc. Many answers were received, some of them with long lists of national and international papers so I got a good material to start with. At BSCE 17 it was also decided to proceed with the matter, and change the name to "Index for data base" and include at least books and audiovisual means. Some members also wanted the data base to contain working papers from BSCE meetings as well as other wellknown papers published in order to promote work in our section of flight safety.

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After some completing questions to members of national committees I have started the work to compile a data base consisting of papers published in reports from all BSCE meetings over the years. This has reduced the task but on the other hand we have indeed carried out

3.5 Working Group Radar and Other Sensors
(Chairman: B. Bruderer, Switzerland).

3.6 Working Group Structual Testing of Airframes
(Chairman: P. Chalot, France).

3.7 Sub-group on Low-Level Military Aircraft
(Rapporteur: E. Schneider, Denmark).

4. **Cooperation with ICAO:**

4.1 Harmonization of ICAO Documentation on Bird Hazards.

4.2 Actual Status of the ICAO Bird Strike Information System.

4.3 ICAO Workshops on Bird Hazards to Aircraft.

4.4 Other Cooperation with ICAO.

5. **Cooperation with other international organizations:**

5.1 EEC Concil Directive on Bird Conservation.
Actual status of the implementation.

5.2 Cooperation with ECAC.

5.3 Cooperation with IATA and other Organizations.

6. **Elections.**

7. **The Mike Kuhring Award:**

7.1 Presentation of the 4th, 5th and 6th Award.

7.2 Proposal for the 7th Award.

8. **Planning for future meetings of BSCE:**

8.1 BSCE 20, planned to be held in the spring of 1988 in Spain.

8.2 Preliminary planning of BSCE 21, spring 1990 in Finland.

9. **Other matters.**

10. **Termination of the meeting.**

ADF616070

BSCE 18/WP 26
Copenhagen May 1986

Index for data base. BSCE papers and documents

L-O Turesson Sweden

Summary

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After some completing questions to members of national committees I have started the work to compile a data base consisting of papers published in reports from all BSCE meetings over the years. This has reduced the task but on the other hand we have indeed carried out

a considerable work over the years so that the reports from the 18 meetings now occupy a half meter of a bookshelf and the total number of papers amounts to about 350. The aim of this compilation is reduced compared to the handling of all available material but I think it's still a good purpose to arrange all our own papers in a lucid way.

Arrangement of the data base

The material from the BSCE reports has been divided into the following 10 sections:

1. Statistics and analysis, Case histories. Risk birds

2. Aerodromes

3. Birds

4. Bird scaring

5. Flight procedures. Warnings

6. Aircraft structural problems and testing of airframes

7. Public relations

8. General on the bird hazard problem

9. Relationship with ICAO. Documentation, IBIS-system, state letters, workshops etc

10. BSCE. Way of working etc

Appendix 1 gives a more detailed description of the division of all material into subsections. It was found suitable to divide the first five sections or chapters into no less than 33 subsections in order to get a good distinction between all our different types of working areas. Concerning this division I had some help by a scetch made up by John Thorpe, CAA, UK so I thank him for his ideas. Thanks go also to Vital Ferry for the help I had in my work from his paper at BSCE 14 "The first ten years of BSCE" which contained a list of all lectures/papers from 1966 to 1975. This compilation made my present work a bit easier. Finally John Widdall from ICAO European office has given me some ideas on the contents.

By these words I would like to hand over the index for data base now at hand to the BSCE community in the hope that the document will att least sometimes make it easier to find out details of the work that has been carried out before within our circles.

Appendix 1

Index for BSCE papers and documents

1. Statistics and analysis. Case histories. Risk birds

1.1 Civil statistics

1.2 Military statistics

1.3 Helicopter bird strikes

1.4 Bird strikes to general aviation aircraft

1.5 Individual airports and bird strikes

1.6 Case histories. Serious strikes

1.7 Collisions and risks concerning particular groups of birds

1.8 General on bird strikes

2. Aerodromes

2.1 Airport planning

2.2 Environment of airports

2.3 Garbage dumps

2.4 Use of land. Ground cover. Handling of grass

2.5 Specific and general studies

2.6 National regulations

3. Birds

3.1 Populations

3.2 Identification. Weights of birds

3.3 Visual observations including nest control
Particular problem birds

3.4 Movements/migration. Use of radar for bird studies

3.5 Migration forecasts

3.6 Birds and weather including biometeorology

3.7 Concentration maps

4. Bird scaring

4.1 Use of pistols and guns. Pyrotechnical projectiles

4.2 Acoustic (distress calls etc)

4.3 Effigies of birds

4.4 Sheltering by nets

4.5 Falconry and radio controlled model aircraft

4.6 Use of lights

4.7 Laser light

4.8 Chemical agents

4.9 General on methods for bird scaring

5. Flight procedures. Warnings

5.1 Operating restrictions

5.2 Pilots and birds. Avoiding of birds

5.3 Warnings

6. Aircraft structural problems and testing of airframes

7. Public relations

8. General on the bird hazard problem

9. Relationship with ICAO. Documentation, IBIS-system, state letters, workshops etc

10. BSCE. Way of working etc

1. Statistics and analysis. Case histories. Risk birds.

1.1 Civil statistics

1.	van Dusseldorp J and Thorpe J	Bird strikes during 1976 to European registered civil aircraft (1978)	13/7
2.	Efanov B and Malakov E	Results of the analysis of birdstrikes to Acroflot registered aircraft for the period from 1970 to 1979 (1981)	15/29
3.	Goryachev V	Analysis of birdstrikes in USSR civil aviation (1974)	9/4
4.	Grubh R	Bird strikes in India (1982)	16/20
5.	Keil W	Birdstrike situation in Lufthansa 1970 (1971)	6/7
6.	Keil W	An analysis of the bird strike reports from Lufthansa (1972)	7/11
7.	Nankinov D	Collisions of Bulgarian civil aircraft with birds (1982)	16/23
8.	Peresempio R	Italian bird strike statistics 1981-1983 (1984)	17/13
9.	Politt W	The problem of birdstrikes in statistics and analysis (1974)	9/5
10.	Rogachev A and Trunov O	Some statistic data on bird strikes to aircraft and helicopters over the territory of the Soviet Union (1977)	12/5
11.	Thorpe J	Analysis of bird strikes	7/12
12.	Thorpe J	Six years of birdstrikes in the UK	8/11
13.	Thorpe J	Birdstrikes during 1972 to European registered civil aircraft	9/2
14.	Thorpe J	Birdstrikes during 1973 to European registered civil aircraft (1975)	10/2
15.	Thorpe J	Birdstrikes during 1974 to European registered civil aircraft (1976)	11/2
16.	Thorpe J	Birdstrikes during 1975 to European registered civil aircraft (1977)	12/2
17.	Thorpe J	Birdstrikes 1977 civil aircraft (1979)	14/11
18.	Thorpe J	Birdstrikes during 1978 to European registered civil aircraft (1981)	15/4

19.	Thorpe J	Birdstrikes during 1980 to European registered civil aircraft (1982)	16/14
20.	Thorpe J	European airlines bird strikes 1976/1980 (1984)	17/3
21.	Thorpe J	Birdstrikes during 1982 to European registered civil aircraft (1984)	17/25
22.	Thorpe J	Birdstrikes during 1981 to European registered civil aircraft (1984)	17/26
23.	Thorpe J	Birdstrikes during 1983 to European registered civil aircraft (1986)	18/21
24.	Trunov O and Rogatchev	Bird strikes to Aeroflot registered aircraft and some general airworthiness requirements (1979, also under 6)	14/30

1.2 Military statistics

1.	Austin T	Military aircraft birdstrike analysis, 1974 (1981)	11/28
2.	Austin T	Military aircraft birdstrike analysis, 1976 (1978)	13/7B
3.	Bird Stirke Committee	Statistics concerning birdstrikes at the BAF 1956 to 1965 (1966)	1/1
4.	Gezelius J and Alerstam T	Bird-aeroplane collisions at low altitudes (1972)	7/10
5.	Hild J	Birdstrikes in the German Air Force during 1968 (1969)	4/4
6.	Hild J	Birdstrikes in GAF 1970 (1971)	6/8
7.	Hild J	Birdstrike situation in GAF (1972)	7/9
8.	Hild J	Birdstrikes, German Air Force 1974-1975 (1976)	11/12
9.	Hild J	Bird strikes in German Air Force 1968-1976 (1977)	12/5
10.	Kingston P	Birdstrikes 1977 military aircraft (1979)	14/12
11.	Kingston J	Military aircraft bird strike analysis (1981)	15/5
12.	Leeming G	Military aircraft bird strike analysis 1979 (1982)	16/15
13.	Leeming G	Military aircraft bird strike analysis 1980 (1982)	16/15a
14.	Leeming G	Military aircraft bird strike analysis 1981 (1984)	17/8
15.	Leeming G	Military aircraft bird strike analysis 1982 (1984)	17/9
16.	Salter A	Military aircraft bird strike analysis 1972 (1974)	9/1
17.	Salter A	Military aircraft bird strike analysis 1973 (1975)	10/3
18.	Thompson M and De Fusco R	1984-85 USAF birdstrike report (1986)	18/8
19.	Turner C	Military aircraft bird strike analysis 1983-1984 (1986)	18/30

1.3 Helicopter birdstrikes

1.	Hild J	Birdstrikes on helicopter in German Air Force (1978)	13/4

1.4 General aviation aircraft

1.	Thorpe J	Some notes on analysis of bird strikes to UK general aviation aircraft (1978)	13/32

1.5 Individual airports and bird strikes

1.	Agat I and Suaretz S	Summary of bird aircraft collisions at Ben Gurion airport 1983 (1984)	17/12
2.	Bakker C	Birdstrikes during 1985 (KLM)	18/34
3.	Lind H	Bird strikes in Copenhagen airport during a 10 year period	17/23

1.6 Case histories. Serious strikes.

1.	Hoffman O	Bird strikes to German registered aircraft in 1983 which caused high repair costs (1984)	17/11
2.	Thorpe J	Bird strikes to engines (1976)	11/3
3.	Thorpe J	Fatal accident to HS 125 executive jet (1976)	11/21
4.	Thorpe J	Accidents and serious incidents to civil aircraft due to bird strikes (1982)	16/16
5.	Thorpe J	Serious bird strike incidents to civil aircraft 1981 and 1982 (1982)	16/16a
6.	Thorpe J	Incident analysis report No 82/1982	16/22
7.	Thorpe J	Serious bird strikes to civil aircraft 1981-1984 (1984)	17/27
8.	Thorpe J	Serious bird strikes to civil aircraft 1984 & 1985	18/4

1.7 Collisions and risks concerning particular groups of birds

1.	Bruderer B	Collisions of aircraft with birds of prey in tue Alps (1978)	13/5
2.	Buurma L	Bird wieght and aircraft speed in bird strike statistics (1982)	16/17
3.	Dekker A and Buurma L	On the spatial and temporal distribution of bird species involved in RNLAF bird strikes	17/14
4.	Grubh R	Whitebacked vulture and Pariah Kik as two major problem birds at Indian aerodromes (1982)	16/19
5.	Short J	Modelling ralative waterfowl risk along low level routes (1981)	15/18

1.8 General on bird strikes

1.	Bakker C	Bird strikes during 1983 (1984)	17/18
2.	Cesbron-Lavau H	Global statistical approach of the birdstrike	10/11
3.	Cesbron-Lavau H	Global statistical approach of the birdstrike (1976)	11/18
4.	Harrison M	Avoiding bird strikes	18/28
5.	Hild J	Reports on birdstrikes in Germany (1968)	3/10
6.	Hild J	Birdstrikes in Germany 1969 (1970)	5/1
7.	Karlsson J	Bird strikes in Sweden 1967-1974 (1975)	10/17
8.	Keil W	Exchange of information about bird-strikes	6/9
9.	Schwarzenbach T	The bird strike reporting system in Swissair (1978)	13/6
10.	Smith T	Study of bird strikes at Canadian airports	15/11
11.	Thorpe J	The computer analysis projekt (1978)	13/8
12.	Thorpe J	Accidents and serious incidents due to bird strikes to transport aircraft (1981)	15/26
13.	Turesson L-O	Proposal concerning the distribution of birdstrike reports (1976)	11/6

2. Aerodromes

2.1 Airport planning

			Ref.
1.	Maron J	Bird strike problems of the projected airport Munchen II (1976)	8/10
2.	Karlsson J and Turesson L-O	Preliminary works before the opening of Malmö/Sturup airport (1973)	11/27

2.2 Environment of airports

1.	Dahl H	Sanctuaries in the vicinity of airports	13/11b
2.	Dahl H	Trees and bushes in the vicinity of airports (1978)	13/11c
3.	Hild J	Agricultural investigations on German air bases (1969)	4/7
4.	Hild J	Meteorological aspects on agricultural methods of scaring birds (1969)	4/8
5.	Hild J	Ecological research of Decimonnannu airfield (1970)	4/4
6.	Hild J	Bird strike problems on airbase Decimonnannu, Sardinia (1984)	17/17
7.	Keil W	Ecological research at Hamburg airport (1967)	2/3
8.	Keil W	Ecological research in aerodrome traffic zone and its results (1972)	7/6
9.	Stenman O	Bird control at Helsinki/Vantaa airport, Finland (1979)	14/33

2.3 Garbage dumps

1.	Dahl H	Garbage dumps in the vicinity of airports (1978)	13/10a
2.	Stone R	Synergised ammonium sulphate in the control of birds at airports. Appendix A (1976)	11/23
3.	van Wessum H	Garbage dump problems in the Netherlands and the need for rules and research	17/34

2.4 Use of land. Ground cover. Handling of grass

1.	Briot J	The attempt to get rid of the wood pigeons (Columba Palumbus) from Orly airport (1976)	11/22
2.	Briot M	Treatment of lawns on the Paris airports (1982)	16/8
3.	Brough T	Experimental use of long grass in the UK (1971)	6/1
4.	Buurma L and Heijink J	Practical and economical aspects of grassland management at some Dutch airbases (1978)	13/33
5.	van Camp M	Some proposals for alternative ground covering vegetation on airfields (1981)	15/19
6.	Dahl H	Use of land in the vicinity of airports (1978)	13/10c
7.	Dahl H	Length of the grass along the runways (1978)	13/11a
8.	Hild J	Mixtures of grass seed for airports (1971)	6/4
9.	Hild J	Special considerations about handling of grassland areas (1973)	8/9
10.	Hild J	Growth prohibiting substances and effects on grassland areas (1976)	11/13
11.	Hild J	A new problem on scaring birds on airfields induced by painting trees and shrubs (1976)	11/14
12.	Hild J	About effects of agricultural and grassland use on airfields - reducing bird populations (1978)	13/14
13.	Klaver A	Longterm grassland exploitation at Sciphol airport, Amsterdam (1982)	16/6

2.5 Specific and general studies

1.	Becker J	General considerations about entomological investigations (1973)	8/8
2.	Bruderer B	Bird problems as discovered at Zurich airport	7/5
3.	Laty M	Risks for birdstrikes created by black headed gulls on Nice/Cote d'Azur airport (1974)	9/10
4.	Laty M	The black headed gulls with their assigned quarters in Nice (1975)	10/9
5.	Seaman E	Recent research findings of USAF in bird control at airfield (1967)	2/1
6.	Stortenbeker C	Bird strike problems at Schiphol airport (1967)	2/2
7.	Stortenbeker C	Progress report of Schiphol airport (1968)	3/5

2.6 National regulations

1.	Dahl H	New Danish regulations regarding management of airports (1984)	17/21
2.	Eis S	Report on permissions granted by the Wildlife Administration in 1985 concerning deviation from the general rules of hunting ..... (Denmark) 1986	18/20
3.	Keil W	Experiences with the bird strike regulations of the Federal Ministry of Transport since 1974 (1979)	14/16

3. Birds

3.1 Populations

1.	Caithness T	Control of a breading population of Larus species near a New Zeeland airport (1984)	17/30
2.	Clausen M	Electronic counting of birds (1973)	8/7
3.	Dutch working party on the prevention of bird strikes	Literature survey of the distribution and group behaviour of gulls in the Netherlands (1986)	15/29
4.	Heirman J	Further lapwing investigations on Beauchevain (1975)	10/6
5.	Heirman J	A Belgian bird strike risk map based on ration bird per area (1975)	10/7
6.	Hild J	Bird flutuations on airfields during the year (1969)	4/10
7.	Holm Joensen A	The use of waterfowl count data in birdstrikes work in Denmark (1975)	10/18
8.	Hunt F	Bird density and the bird strike risk (1976)	11/15
9.	Jacobs T	Experiment of presentaiton of actual bird intensity in a "0 to 8" scale on a display unit (1976)	11/10
10.	Kuyk F	Distribution patterns of gulls around Schiphol airport and Leeuwarden airbase in the period August 1980-April 1981 (1981)	15/27
11.	Lindh H	The problem of black-headed gulls (Larus Ridibundus) breeding near airports (1986)	18/19
12.	Louette M	The distribution of the black headed gull in Belgium (1972)	7/2
13.	Mikx F	Hawks at Leeuwarden airbase (1969)	4/9
14.	Slot J	Hawk at Leeuwarden airbase (1968)	3/2
15.	Ulfstrand S	How many birds are there in Sweden? (1975)	10/21

3.2 Identification. Weights of birds

1.	BSCE	Identification of feather remains	15/30
2.	De Bont A and Boomans J	Strategies for the identification of bird remains from birdstrikes (1986)	18/12
3.	Brom T and Buurma L	The quality of identification: a microscopic key to determination of feather-remains (1979)	14/19
4.	Brom T and Buurma L	The quality of identification: its effects on birdstrike statistics (1979)	14/20
5.	Brom T	Identification of bird remains for birdstrike analysis: A litterature synopsis (1986)	18/23
6.	Brough T	Average weights of birds	17/10
7.	Finely H	Birdweight and airport manual (1968)	3/3
8.	Laybourne R	Identification of bird remains from bird aircraft incidents by the microstructure on the downy part of the feathers (1984)	17/24
9.	Lind H	The identification of bird remains as part of the bird strike reporting procedure (1978)	13/3
10.	Rochard J and Horton N	Birds killed by aircraft in United Kingdom 1966-1976 (1977)	12/4
11.	Solman V	Amino acid contents of birds (1968)	3/9

3.3 Visual observations including nest control. Particular problem birds

1.	Bentz P	Greenland snow buntings in transit at Andöya airport in northern Norway (1984)	17/22
2.	Blokpoel H	Ring-billed gull versus flight safety; a continuing conflict in Ontario, Canada (1984)	17/35
3.	Bruderer B	Bird observations at Zurich airport	13/18
4.	Dahl H	Homing pigeons in the vicinity of airports (1978)	13/10b
5.	Hild J	German system of visual observation of bird migration	5/6
6.	Jacoby V	Ornithological researches in the USSR (Birdstrike problems) (1972)	7/4
7.	Laty M	Birds on airports. The reason for their presence (1982)	16/9
8.	Lind H	An attempt to reduce Herring Gull population on Saltholm (1971)	6/2
9.	Ruiz J and Morera P	Study structure of bird and ecosystems in Spanish airports (1986)	18/33
10.	Suter W	Roosting and feeding flights of black headed gulls in the region of Zurich airport (1978)	13/19

3.4 Movements/Migration. Use of radar for bird studies

1.	Alerstam T	Spring migration of cranes over southern Scandinavia (1975)	10/16
2.	Barra B and Labozzetto B	Air traffic control radardata analysis and bird movements detection (1986)	18/22
3.	Becker J	The use of radar data for birdstrike prevention in Germany (1986)	18/5
4.	Bertrand and Dupont	Bird observation system Semmerzake (1984)	17/37
5.	van Berwielen	Report on the second radar W G meeting (1968)	3/11
6.	Blackwell F	Use of bird activity modulation waveforms in radar identification (1972)	7/1
7.	Blackwell F	Analysis and classification of bird flights and echo data fraom radar	9/15
8.	Broadfoot	Progress in the detection of bird moements at Gold lake (1968)	3/12
9.	Brough T	Estimating the physical dimensions of birds by radar (1974)	9/16
10.	Bruderer B	Bird/Weather/Radar work in Switzerland	6/13
11.	Buurma L	Autumn radar study of the coastal migration in western Holland (1977)	12/12
12.	Buurma L	Pattern of bird migration over the Netherlands: a classification illustrated with radarfilm (1979)	14/21
13.	Dupont G	Bird observation system Semmerzake (1986)	18/16
14.	Ferry V	Birdwarning with the aid of airfield radar (1968)	3/6
15.	Ferry V	Radar observation methodology and procedures used by ATC (1972)	7/13
16.	Gauthreaux S	Image intensification: A new method of studying nocturnal bird migration (1979)	14/8
17.	Hild J	European bird migration map	3/13
18.	Hild J	Prograss report European bird move-	4/1

		ment W G (1969)	
19.	Hild J	Report about Bird movement W G	6/14
20.	Hild J	Result of bird movement W G (1973)	8/3
21.	Hild J	Agenda for meeting Bird Movement Working Group (1986)	18/11
22.	Houghton W	Research on the radar properties of birds in UK	3/8
23.	Houghton W	Radar echoing areas of birds (1969)	4/6
24.	Houghton W	Bird/weather and anomalous propagation echoes on radar (1970)	4/5
25.	Houghton W	ATC and the bird radar surveillance without tears (1971)	6/12
26.	Houghton W	Highlights of the NATO-Gibraltar bird radar study	8/6
27.	Houghton W	A radar study of wild duck (1975)	10/1
28.	Houghton W, Blackwell F, Brought T and Wilmot T	A radar study of waders (1976)	11/4
29.	Hunt F	Radar detection of birds in an operational environment	9/14
30.	Jacoby V	Local and migratory movements of birds (1969)	4/2
31.	Jacoby V	Migrating birds and their danger to aeroplanes (1976)	11/5
32.	Jacoby V	Possibility to use precision approach radars for bird strike prevention (1984)	17/7
33.	Keil W	First results on crane migration (1967)	2/5
34.	Komarov V and Vasilenko	Results and perspectives of radar ornithology in the USSR (1982)	16/11
35.	Larsson B	Height distribution of bird movements in southern Sweden meassured by radar Sept-Oct 1975 (1976)	11/7
36.	Laty M	Geographical influence on flights of migratory birds in southeast of France (1979)	14/7
37.	Rooseleer G	Daily movements of black headed gulls in the region of Brussels airport (1981)	15/16
38.	Soetens G	Experimental bird counting with a real time computer (1975)	10/8

3.5 Migration forecasts

1.	Alerstam T and Larsson B	A forecast system for bird migration in Sweden	14/4
2.	Blokspoel H	The predictability of spring migration of snow geese across southern Manitoba, Canada (1979)	14/9
3.	Blokspoel H	Prediction of the spring migration of snowgeese (1975)	10/10
4.	Hild J	Procedure of birdstrike warning forecasting advisory in GAF (1973)	8/4
5.	Hild J	Birdstrike-risk-forecast (1977)	12/1
6.	Hild J	Biophenological observation-and information service in GAF, a help for birdstrike-risk forecast (1978)	13/20
7.	Larsson B	Continous work with the migratory bird forecasting system presented at BSCE 12	13/16
8.	Louette M	Bird migration forecasting (1973)	8/1
9.	Raböl J	Forecast models for bird migration intensities in Denmark (1974)	9/8
10.	Robijn R	Computational procedure for bird migration forecasting (1973)	8/2
11.	Noer H	Recent development of the Danish bird migration forecast system (1971)	6/11

3.6 Birds and weather including biometeorology

1.	Alerstam T	Visable bird migration and weather (1974)	9/11
2.	Bruderer B	Multiple regression analysis of weather and migration data (1974)	9/7
3.	Bruderer B	Weather dependence of height, density and direction of migration in Switzerland (1977)	12/11
4.	Gauthreaux S	The influence of weather variables on the density of nocturnal migration in spring (1977)	12/10
5.	Hild J	Large scale weather situations and influence on bird migration during seasons of the year (1978)	13/17
6.	Leith H	Some remarks on the influence of biometeorology on birds life (1981)	15/12

3.7 Concentration maps

1.	Heirman J and Boomans J	Low level flight birdstrike risk map for Belgium (1976)	11/17
2.	Hild J	Vulnerability maps (1968)	3/7
3.	Hild J	Bird hazard maps for Europe (1972)	7/8
4.	Joensen A	European bird hazard map, Denmark (1975)	10/14
5.	Karlsson J	Surveys of bird concentration areas as a tool in aviation safety work with an example from Sweden (1977)	12/13

4. Bird scaring

4.1 Use of pistols and guns. Pyrotechnical projectiles

1.	Manuel J	Exxperimntal comparison of three bird strike test techniques using different projectiles (1984)	17/31
2.	Short J	Evaluation of pyrotechnic birdscare devices (1981, not in the report)	15/9

4.2 Acoustic (distress calls etc)

1.	Beuter K and Weiss R	Properties of the auditory system in birds and the effectivness of acoustic scaring signals (1986)	18/3
2.	Efanov B	Increase of efficiency of the mobile bio-accoustic system for scaring birds within the airport area (1986)	18/32
3.	Möllen G	Use of distress calls for scaring birds on airfields in Norway	6/3
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5.	Rodrigues de la Fuente F	Falconry for the control of birds on airports	6/5

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5.	Dar D	Treatment for repelling birds at Ben Gurion international airport (1977)	12/9
6.	Hild J	Some investigations on the efficiency of radiation and teargas (1969)	4/11
7.	Laty M	Essias en cours du Repulsit RETA	13/28
8.	Lind H	Attempts to control the breeding population of the herring gull near Copenhagen airport (1977)	12/7
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18.	Hild J	New organization of German Board for bird strike prevention	15/25
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20.	Jacoby V	Introduction to birdstrikes in USSR (1974)	9/3
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29.	Rooseleer G	A proposal of a check-list for bird strike prevention on airfields (1981)	15/15
30.	Short J	Handbook on bird management and control (1981)	15/17
31.	Seubert J	Current activity concerning the U.S bird/plane strike problem (1975)	10/22
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38.	Suaretz S	Birdstrike problems at Ben-Gurion international airport (1977)	12/14
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9. Relationship with ICAO

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1.	Dahl H	Harmonisation of ICAO documentation on bird hazards (1984)	17/20
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4.	Wilde K	ICAO activities related to bird strikes (1979)	14/28

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5.	Dahl H	Agenda for Plenary Meeting on Thursday 29 May, 1986 - Friday 30 May, 1986 at 09.00 am	18/25
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7.	Dallo E	The future of BSCE (1981)	15/22
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9.	Turesson L-O	Code of practice of BSCE (1981)	15/20
10.	Turesson L-O	Way of working of Bird Strike Committee Europe (1982)	16/2
11.	Turesson L-O	BSCE data bank. Proposal for implementation (1984)	17/1
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ADF616071

BSCE 18/WP 27
Copenhagen, May 1986

NATURE RESERVE AUTHORITY ISRAEL AIRPORTS AUTHORITY

BIRD HAZARD AT BEN-GURION AIRPORT

I. Agat and Sh. Suaretz

General

Israels largest Int'l Airport lays in a rather moderate and comfortable weather region, which creats very good conditions for the development of fauna and flora, both natural and cultivated including birds. Like other regions in the country birds of various kinds and species live in this area. Among which resident's, wintering and summering ones. some live in the region the whole year and others are wintering, summering or passing by.

The Birds

A) Winter months (October - April)

Hundreds of thousands of birds of various biotops winter in the country. Many of them appear in the airport's region, the most problematic to aviation are the following:

1) Gulls: mostly black headed gulls (Larus ridibundus), some Hering gulls (L. argentatus) and black backed gulls (L. fuscus).

This population starts to appear in October, their numbers increasing within a short time and reachs some ten of thousands in the area. Their activity is mostly evident in two major ways:

1.1 They comute each morning at sunrise to their feeding sources which are scatered throughout the region and mainly to the "Hiria" garbage dump located about 4 km's west of the airport on the prolonged center line of runway 12-30. Many of these gulls continue their flight to the "Modiin" garbage dump located about 4 km's east of the airport and along the prolonged center line of runway 08-26. Towards sunset, the gulls, fly back, more or less along the same path to the roost area on the mediteranean beach. This daily movement takes place at an altitude of up to 1000 feet and in rather large, flocks numbering hundreds and some times thousands of birds.

1.2 Feeding and resting activity during the day hours - in various places around the airport, but mostly in Hiria - when from time to time the gulls take off and hoover at an altitude of up to 3000 feet, using hot air "termics" over the final approach flight path of runway 12.

In rainny days when the runways are wet and bright, Gulls are expected to land for their rest on the runways. They may also land on water reservours and pools, or on the fields in the area. Especially attractive are fields covered with plastic sheets and shaw gloosy.

2. Lapwings (Vanellus vanellus): The Lapwings normaly appear in the airport region in November and scatter in small flocks in the fields along the runways. Cultivated, open fields or fields covered with low vegetarian are more attractive for them. Than the Lapwings may cross the runways or stay close to them including for the night rest. In the last few years it seems that the number of Lapwings wintering in the area has sharply decreased and do no exceed a few hundreds.

3. Ducks: Tens or even hundreds of Teals (Anas crecca) and Mallards (Anas platyhunchos) appear normaly in October and stay in open drainage tranches or ponds.

Since any suspicious change causes their take off, their movement is mostly unexpected. In their fast flight they may cross runways, even those which are rather far from their rest places.

4. Passerines: Although the danger from these birds is rather limited, problems are expected from few kinds which appear in large flocks like the skylark (Alauda arvensis) the Starling (Sturnus vulgaris) ect.

B) Spring month (March - April)

In this season the mass movement of migrating birds in expected - among which some large birds like Pelicans (Pelicanus onocrotalus). Stroks (Ciconia Ciconia) and various Raptors. They usualy pass in large flocks but some times as singls also.

This movement highly increases in very hot days when the easterly wind "pushs" the birds westbound and they use the hot air "termics" to continue their glide northbound. In these cases the flight altitudes may vary from a few tens up to a few thousands of feet. Some flocks of storks and Black kite (Milvus migrams) have discovered lately the two garbage dumps due to the large amount of food available.

From time to time a large flock of migrating birds may land for rest in fields surrounding the runways.

C) Summer month (April - August)

The numbers of birds in this season are normaly small though the activity of the residents and summering birds is very intensive and conected to breeding and rearing their offsprings.

1) Spur winged plover: (Hoplopterus spinosus). This population is rather stable in the region but their danger is mainly in the summer season since they build their nests on the ground in open fields and many times close to runways and the new born chicks might walk on runways surfaces looking for food with their parents accompaning them for protection.

2) Stone Curlew: (Burhinus oedicnemus). Their behaviour is very similar to the previous one although it's population is rather smaller and stays during the summer only.

3) Turtle dove: (Streptopelia turtur). The activity of this bird is evident all over during the summer. It's danger comes mainly when they fly to and from their feeding sources. This bird eats seads scatered in open fields some of them along the runways, a fact which causes them to cross the runways in flight. Collared doves (S. decaocto) and pigeons were observed some times.

4) Raptors: The Kestrel (Falco tinnunculus) is the most active raptor, while at night the Barn Owl (Tyto alba) is the most active one. The danger of Raptors to aircraft is mainly when they try to catch the offsprings of other birds or when they look for voles and other small animals in the fields close to runways.

D) Fall month (August - September)

This is the great southbound migration period, which defers from the spring migration in the combination of species, then numbers, the flight pathes and the amount of time they use to stay in the region.
The numbers of Raptor is now much greater and many use to land for roost in the forests and woods surrounding the airport.
In these cases low flight might take place acroos the final approach flight path and on the runways.

E) Throughout the year

The bird's residents population include many species among which those already mentioned in the summer season and others which do not place special hazards to aviation and thus not mentioned.

1) Chukar Partridge (Alectoris chukar): This bird lives in the airport in flocks and families counting togather a few hundreds and capable of baring many chicks.
Their activity looking for food (which is usualy vegetarian) is normaly by foot and takes place in the early morning and late Afternoon. When they do fly for some reason they are expected to cross runways at an altitude not exceeding 30 feet and thus placing a real hazard to aircraft due to their rather high weight. (500 - 700 gms).

2) Cattle Egret - (Bubulcus ibis): This bird uses to cross or get close to runways while flying to and from feeding sources in fields, garbage dumps and other places where they may find small creatures and food remains. They mostly fly in small flocks or as singls. This movement which normaly do not exceed 100 feet greatly increases during the breeding period since one of their prefered nestling places is located a few kilometers from the runways.

3) Hooded Crow (Corvus corone cornix): The resident population amounts to about 50 birds and is very active in the airport, where they find a rich variety of food, like remains of flight catering which might fall on the ramps, corps of dead birds, hare's carcasses (which were hit by aircraft, Pecan nuts from a large plantation adjacent to one of the runways. (the birds use to collect the nuts and bring them to the runway in order to hit and open them for food.
As part of this activity the crows cross runways at an altitude of up to 100 feet.

4) Pigeons (Columba livia/domestica): The local population includes a few hundreds of birds which use various instalations like hangars and storage halls for rest and breeding. They find food in various places among which fields along the runways especialy when they are covered with crops like corn, beans or wheat.
More pigeons are added to this population from near by villiages, thus creating a rather heavy movement, especialy during the seading and crops collecting season, over the runways at an altitude of up to 100 feet.

Ways used to diminish Birds hazards

A bird strike prevention unit operats on a permanent basis and throughout the year at Ben-Gurion Airport. The unit is funded through a bilateral contract by the Airports Authority and operated by the Israeli Naturl Reserves Authority. The unit colaborats with all the parties concerened and supervises all other airports of the Airports Authority as well.
The basic activities of the unit are the follwing:

1. Daily inspections of the runways and the fields surrouding them during which the birds movements are observed. Any activity that might endanger the flights is reported immidiatly to the control tower.

2. Farmers cultivating the land surrounding the runways are siged on a contract with the Airports Authority.
   According to this contract they are allowed to grow only those crops that are approved by the Authority as per the unit instructions.
   The daily inspections are used to control the activity of the farmers and the ensure that they do adhere to the instructions.
   The major element in the decision on the aproval of permitted crops is the avoidance of any kind of food that may atract birds.

3. When birds which might place any hazard to aviation are observed various systems are operated immidiatly:
   - Transmit of distress calls or other voices by means of a permanent device installed in the fields, or a mobile one from a viehcle.

   - Gas canons of different kinds are activated.

   - Shell crakers from a gun or rifle are fired.

   - Coloured vanes, weather cochs or small wind mills are placed.
     In those locations were the activity of low flying birds is expected like chukars which cross the runways, 3 meters high nets are placed along the runway to prevent the flight across it.

- In open drainage tranchs and other places where water may accunulate strings are put over the water to prevent waterfowe from landing.

- In special cicrumstances permission are granted for hunters, who are allowed subject to the nature preservation low and under supervision to hunt partridges, pigeons and sometimes ducks.

4. In the two garbage dumps and especialy in Hiria special activity takes place. The most effective tool is a radio controlled aircraft. These activities help to prevent the Gulls and Storks from flying over the final approach of runway 12.

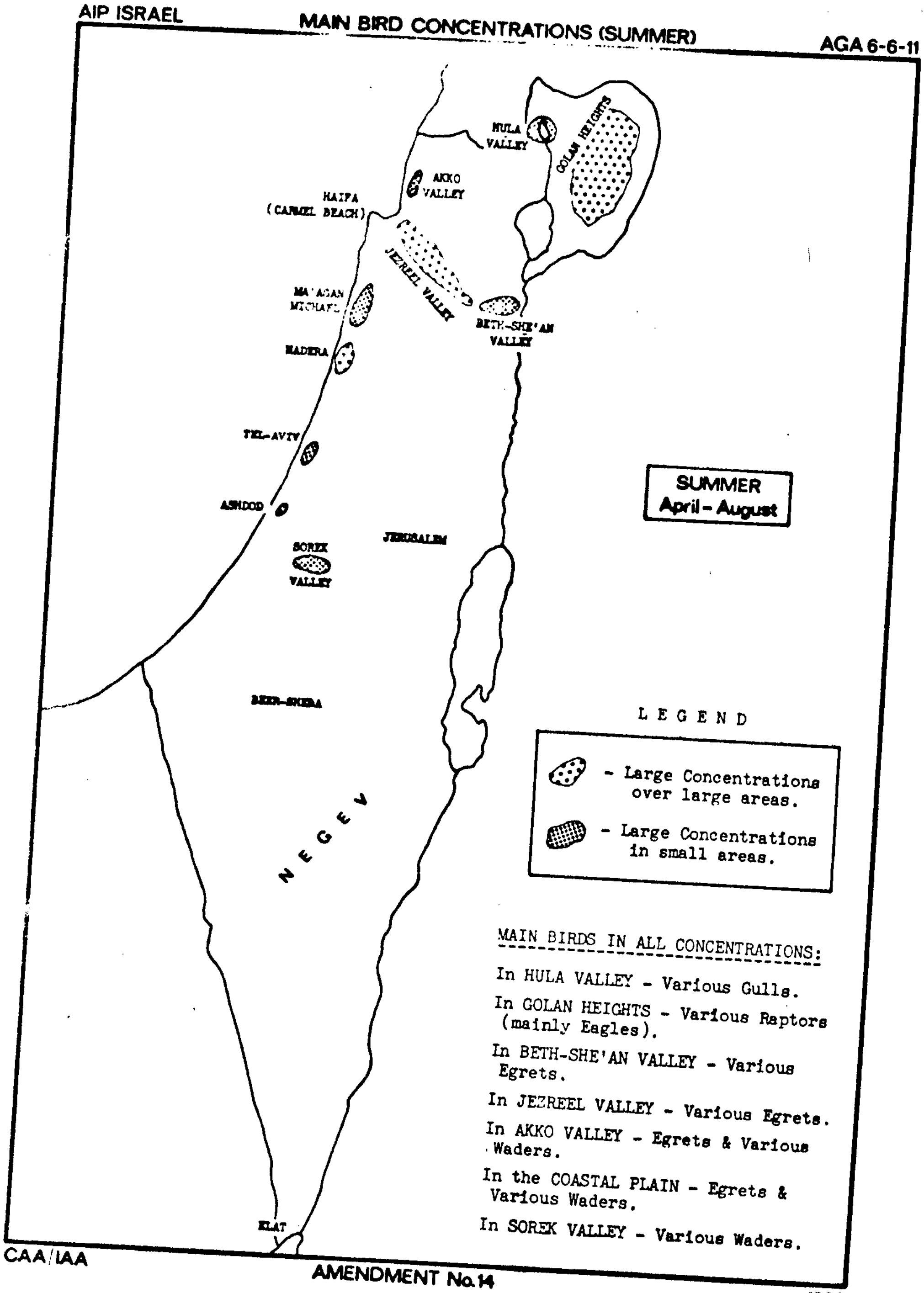
5. The unit is also engaged in other activities such as:
   - of hunted or hid birds are exemined in order to learn more about the birds prefered food.

   - Birds remains are collected immidietly after every reported strike in order to identify the bird which caused the strike.

6. The unit collects all the relevant data including bird striks and observations on which research and many practical conclusions are based.

7. From time to time experiments with new possible tools are executed such as wires causing electrical shock used to scare pigeons, or the use of cannon nitting in order to catch large numbers of birds in their concentration sites like Gulls or Storks.

8. The unit colaborats with various bodies abroad, especialy the B.S.C.E with which we exchange information. We regularly take part in the periodical me tting of the B.S.C.E, a fact that contributes to our achievments at the airport.



MAIN BIRDS IN ALL CONCENTRATIONS:

In HULA VALLEY - Various Gulls.

In GOLAN HEIGHTS - Various Raptors (mainly Eagles).

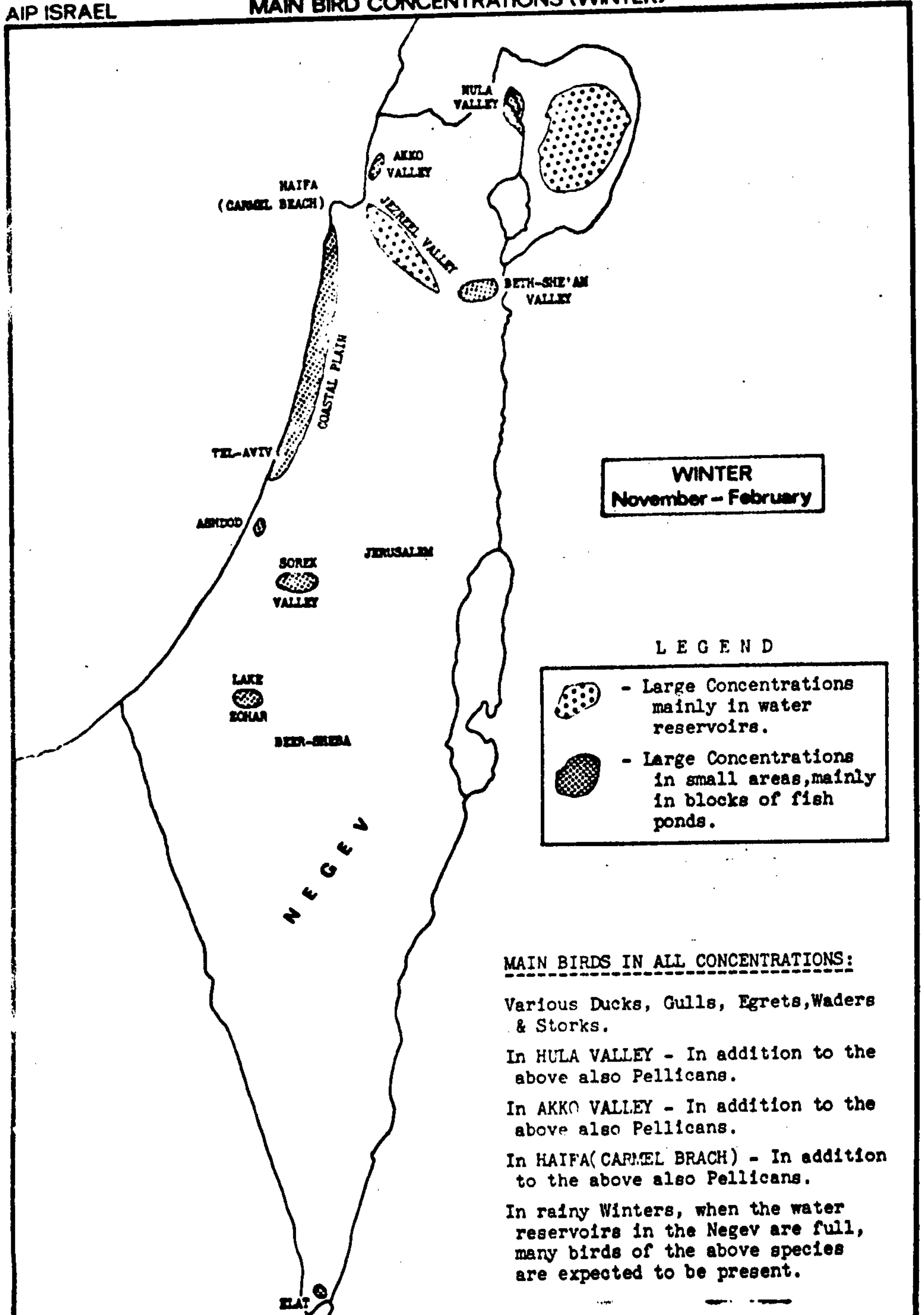
In BETH-SHE'AN VALLEY - Various Egrets.

In JEZREEL VALLEY - Various Egrets.

In AKKO VALLEY - Egrets & Various Waders.

In the COASTAL PLAIN - Egrets & Various Waders.

In SOREK VALLEY - Various Waders.



MAIN BIRDS IN ALL CONCENTRATIONS:

Various Ducks, Gulls, Egrets, Waders & Storks.

In HULA VALLEY - In addition to the above also Pellicans.

In AKKO VALLEY - In addition to the above also Pellicans.

In HAIFA(CARMEL BRACH) - In addition to the above also Pellicans.

In rainy Winters, when the water reservoirs in the Negev are full, many birds of the above species are expected to be present.

BEN-GURION AIRPORT

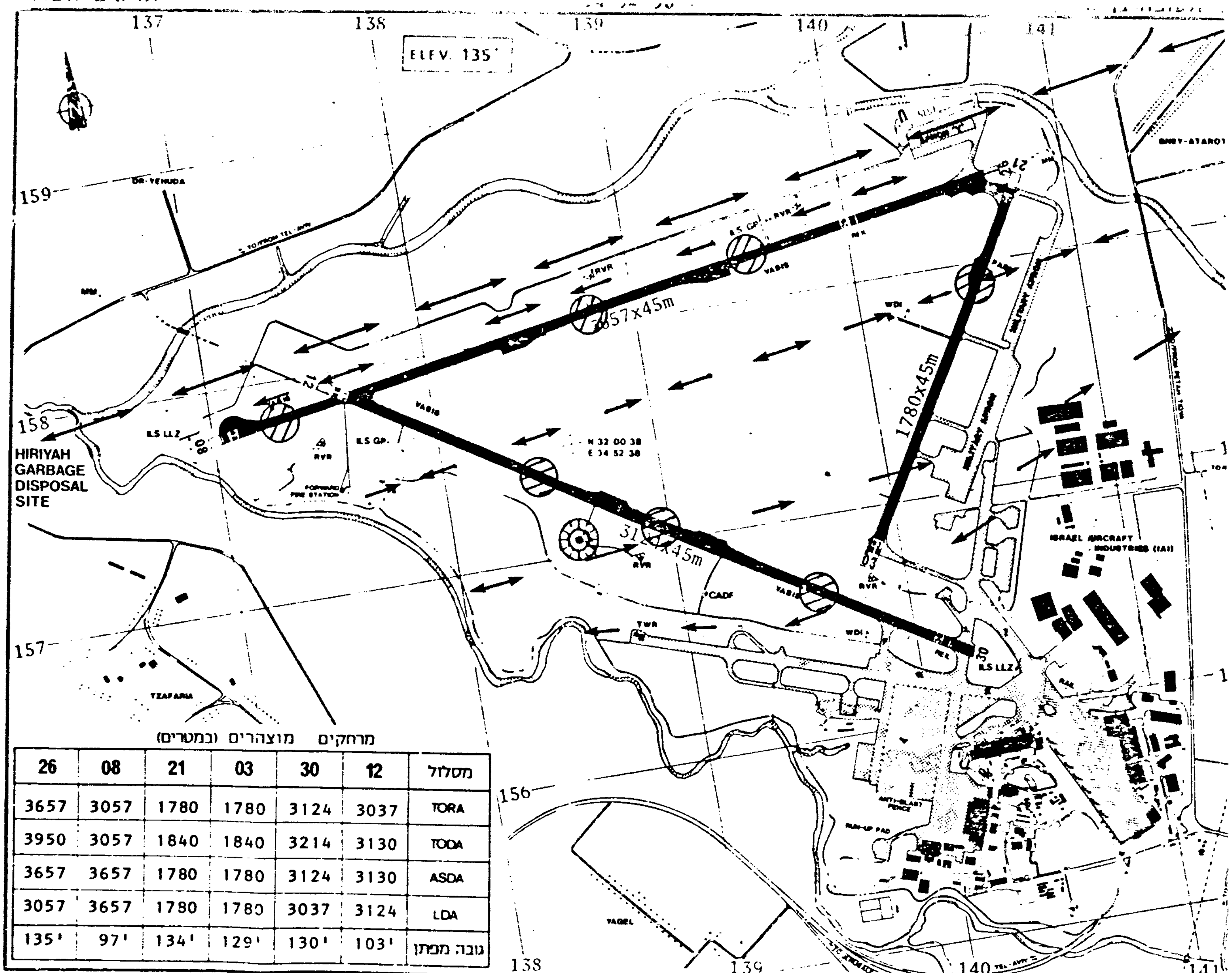
CHART I -

WINTER BIRD MOVEMENT

- REGULAR GULLS MOVEMENT DURING MORNING & EVENING HOURS BETWEEN THE GARBAGE DUMPS.

- GULLS MOVEMENT OVER RUNWAYS ESPECIALLY DURING RAINY EVENINGS & MORNINGS IN ADDITION TO THE ABOVE MOVEMENTS.

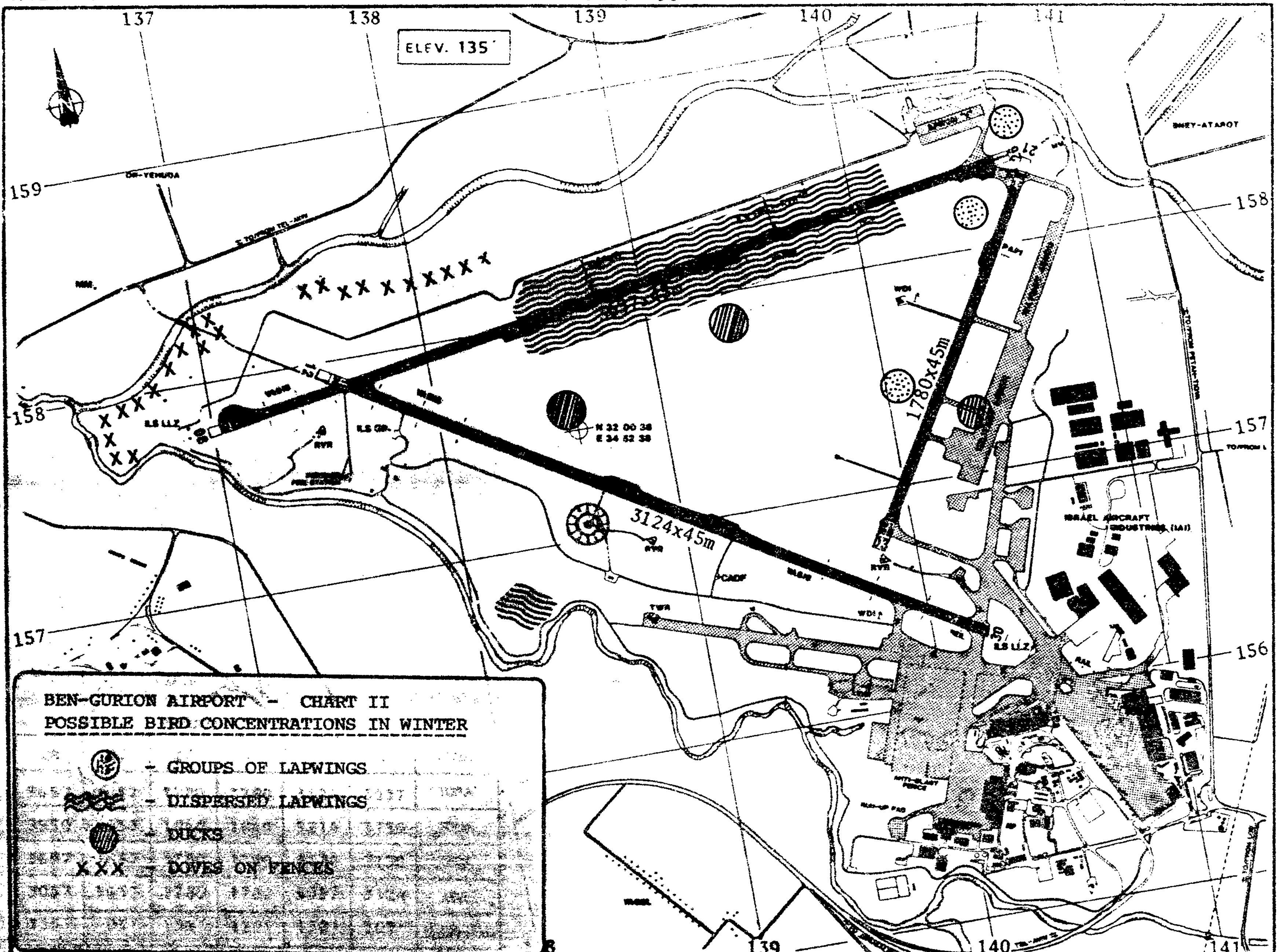
- RESTING SITES FOR GULLS & BEETLES EXPECTED ON RAINY DAYS AMONG THE RUNWAYS AND ADJACENT FIELDS.



מרחקים מוצהרים (במטרים)

26	08	21	03	30	12	מסלול
3657	3057	1780	1780	3124	3037	TORA
3950	3057	1840	1840	3214	3130	TODA
3657	3657	1780	1780	3124	3130	ASDA
3057	3657	1780	1780	3037	3124	LDA
135'	97'	134'	129'	130'	103'	גובה מפתן

1986 נזאי רש"ת/חטיבת מבצעים דכון מס' 8


32° 00' 38" N
34° 52' 38" E
ELEV. 135'
137
138
139
140
141
159
158
157
156
1780x45m
3124x45m
N 32 00 38
E 34 52 38
ISRAEL AIRCRAFT INDUSTRIES (IAI)
BNEY-ATAROT
BEN-GURION AIRPORT - CHART II
POSSIBLE BIRD CONCENTRATIONS IN WINTER
- GROUPS OF LAPWINGS
- DISPERSED LAPWINGS
- DUCKS
XXX - DOVES ON FENCES

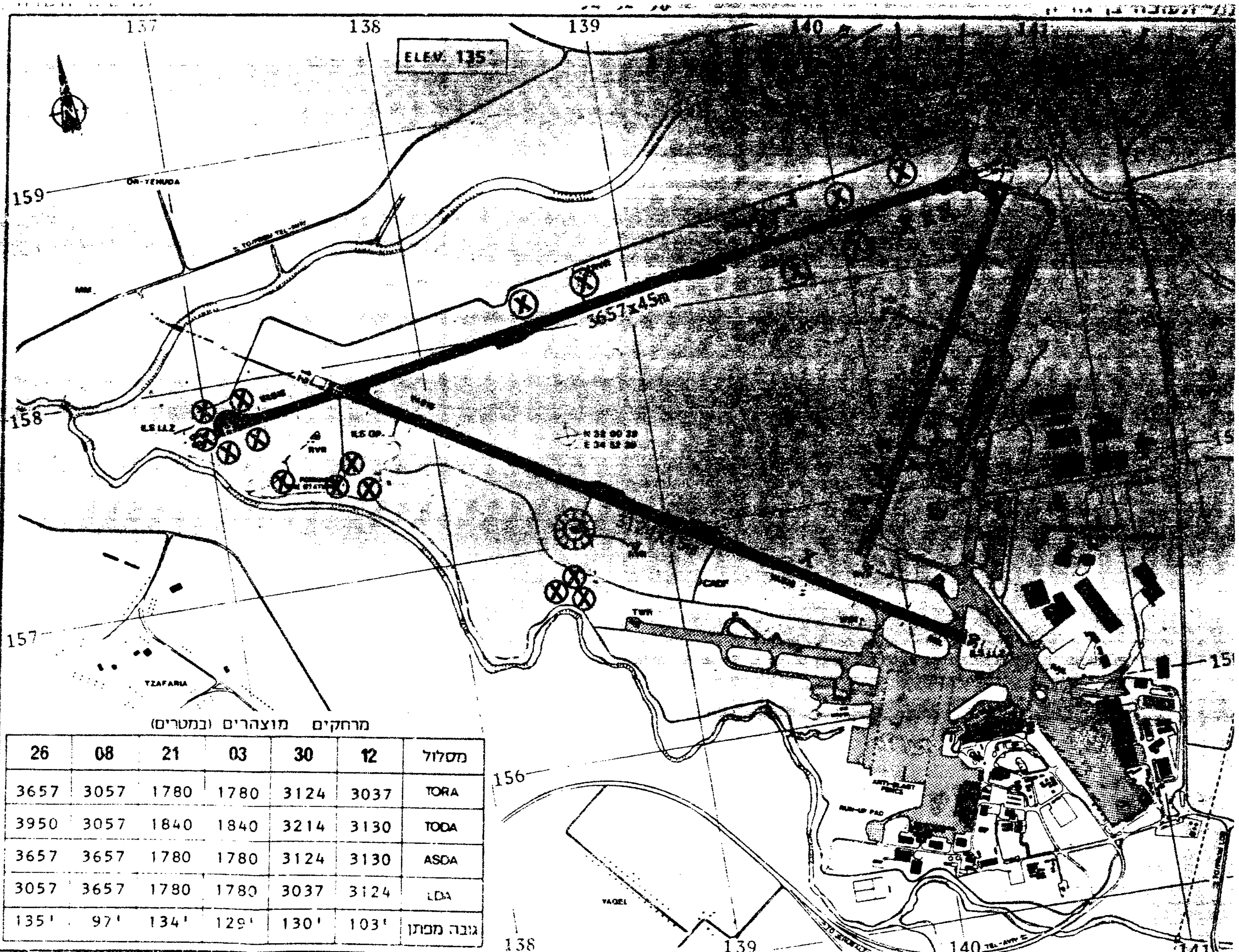
EN-GURION AIRPORT .

CHART III

SIBLE RESTING SITES NEAR RUNWAYS PRING AND SUMMER)

- SPUR-WINGED PLOVERS AND

DOVES



מרחקים מוצהרים (במטרים)

26	08	21	03	30	12	מסלול
3657	3057	1780	1780	3124	3037	TORA
3950	3057	1840	1840	3214	3130	TODA
3657	3657	1780	1780	3124	3130	ASDA
3057	3657	1780	1780	3037	3124	LDA
135'	97'	134'	129'	130'	103'	גובה מפתן

1986 מאי

רש״ת/חטיבת מבצעים

עדכון מס' 8

BEN-GURION AIRPORT

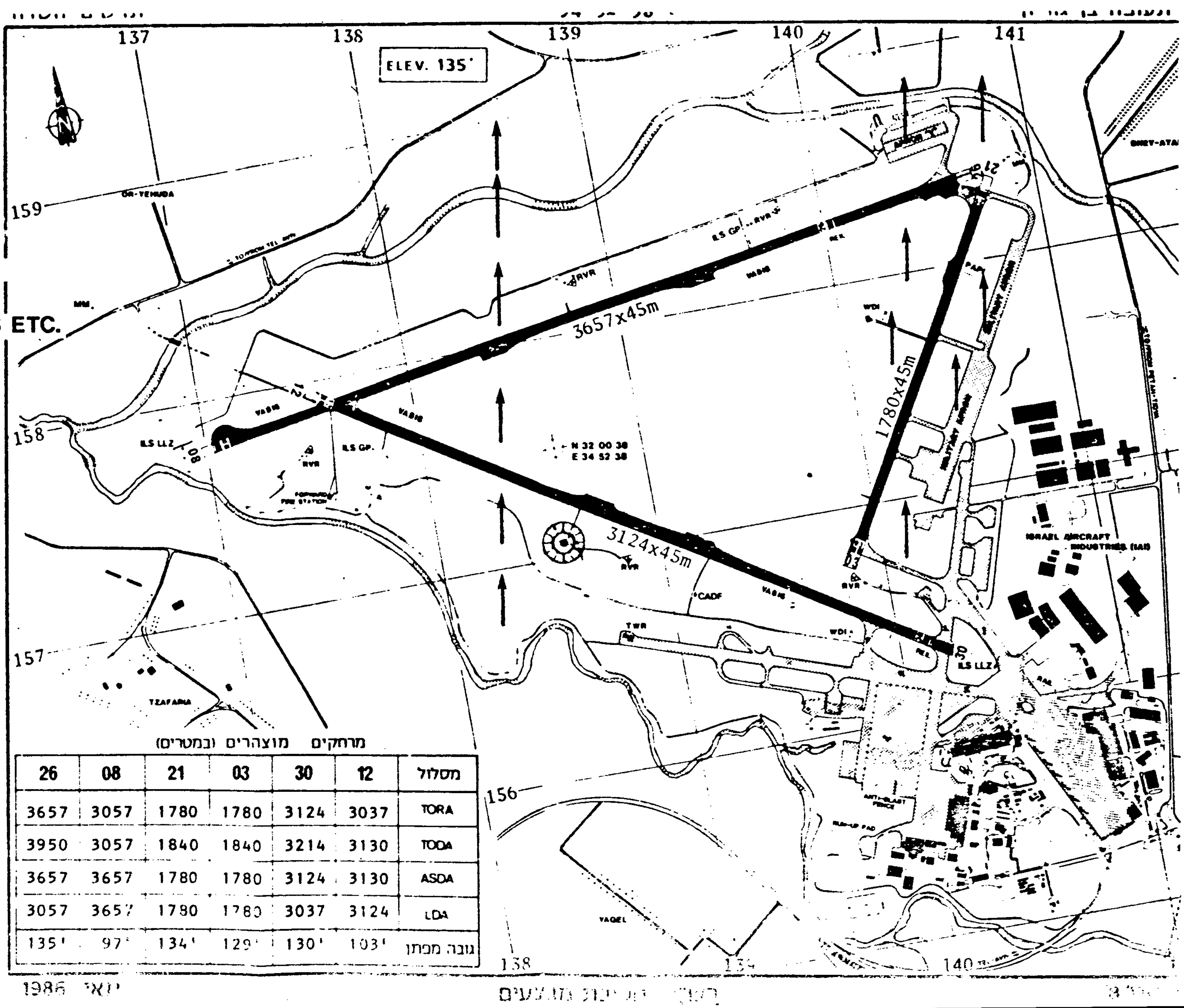
CHART IV

[NO]RTHERN BIRD MIGRATION

IN SPRING (APR-MAY)

[O]N HOT DAYS AND DAYS DURING
[W]HEN EASTERLY WINDS PREVAIL)

[S]TORKS, RAPTORS, PELICANS ETC.



מרחקים מוצהרים (במטרים)

26	08	21	03	30	12	מסלול
3657	3057	1780	1780	3124	3037	TORA
3950	3057	1840	1840	3214	3130	TODA
3657	3657	1780	1780	3124	3130	ASDA
3057	3657	1780	1780	3037	3124	LDA
135'	97'	134'	129'	130'	103'	גובה מפתן

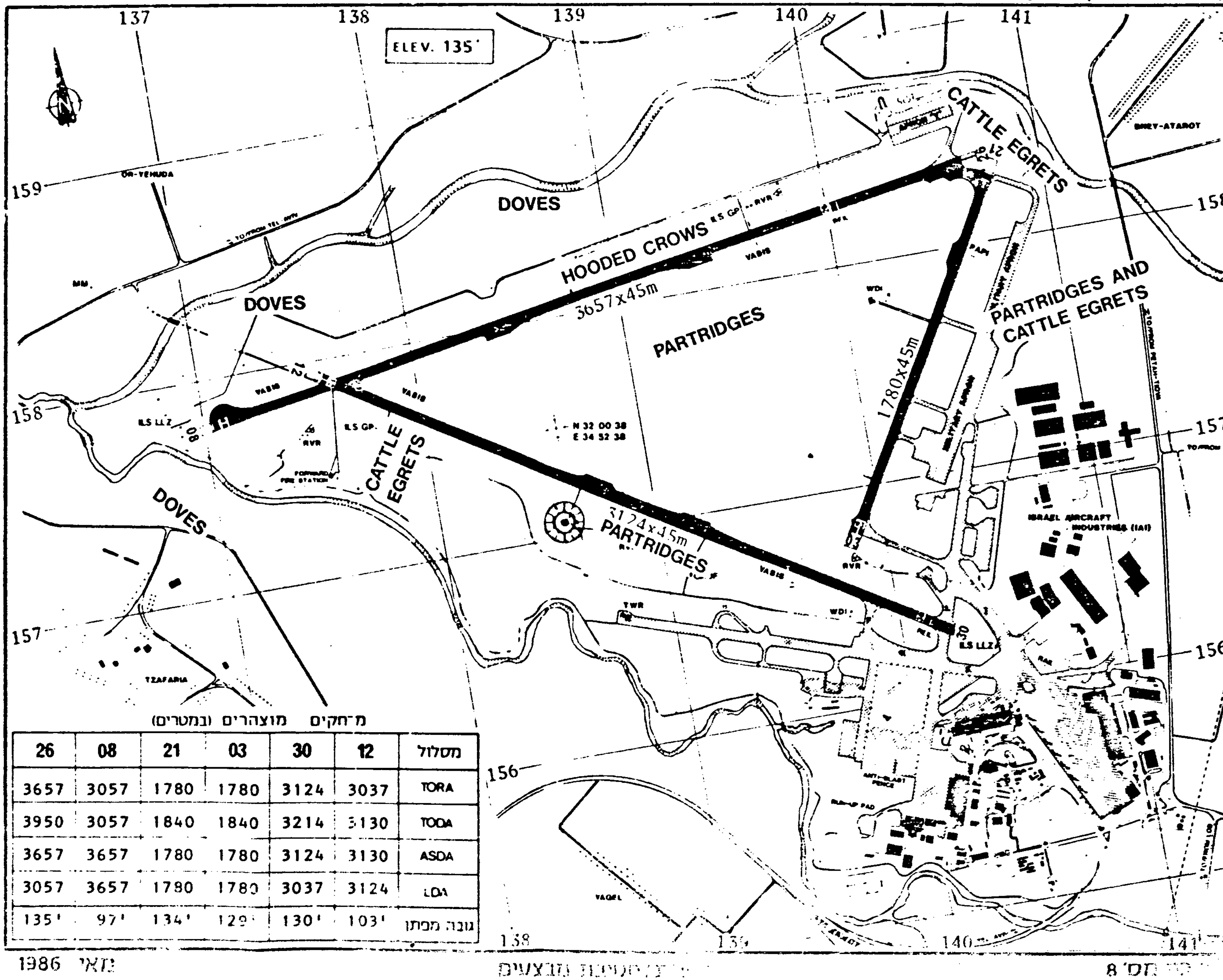
1986 יוני

BEN-GURION AIRPORT

CHART V

BIRD RESTING SITES

(ALL YEAR ROUND)



מ־חקים מוצהרים (במטרים)

26	08	21	03	30	12	מסלול
3657	3057	1780	1780	3124	3037	TORA
3950	3057	1840	1840	3214	3130	TODA
3657	3657	1780	1780	3124	3130	ASDA
3057	3657	1780	1780	3037	3124	LDA
135'	97'	134'	129'	130'	103'	גובה מפתן

ADF616072

BSCE 18/WP 28
Copenhagen, May 1986

AVOIDING BIRD STRIKES

The following article was published in the November 1983 issue of Commuter Air. It is being reprinted with the permission of the author, Mr. Michael J. Harrison.

Bird hazards to aircraft can create serious inflight emergency conditions if the pilot and crew are not prepared to handle the situation. As a pilot who experienced two serious bird strikes which required emergency landings, and as a biologist who has spent the last 9 years working on bird hazards to aircraft, some personal observations may assist other pilots in dealing with a mid-air bird strike.

Any bird, regardless of size, should be considered as a potential hazard, especially when you are flying enroute. The speed of the aircraft dictates the force of impact--the faster you are flying, the greater the impact forces. As speed doubles, the kinetic energy which must be dissipated on impact increases by a factor of four. Consequently, if you must descend into an area of high bird concentrations, consider your approach speeds.

At what altitude are you safe from birds? Strikes have been reported as high as 33,000 feet, and ducks and geese have been observed at and above 20,000 feet MSL. These altitudes are the exception rather than the rule. Over 90 percent of all civil bird strikes in the United States occur below 3,000 feet. At what altitude do you usually flight plan for and fly during the fall and spring bird migrations?

There are essentially two major risks associated with birds: windshield penetrations and engine ingestions. Windshield penetrations usually occur on climbout or while flying at higher speeds during cruise. Commuter or air taxi operators frequently fly at lower altitudes where birds share the airspace. A typical cockpit penetration can result in facial lacerations, cuts on the hands and face, and structural damage to the aircraft.

Because electrical panels and circuit breakers are located behind the pilot or copilot, electrical failures and electrical fires may also occur. In air taxi operations, injury to passengers is possible. Wind blast through the hole in the windshield can make cockpit communications impossible and radio communications unintelligible. The loss of communication ability can seriously compound any emergency procedure.

The spinning propeller in front of the windshield is no protection. In high speed situations, pilots should consider initiating a climb to reduce speed and wind blast, and consider flying above flocks of birds. With the windshield missing, changes in airflow may affect the pilot's ability to control the aircraft at slower speeds. Don't stall the aircraft in the traffic pattern because you failed to perform a controllability check.

In an engine ingestion situation, damage can vary. On turbine or turboprop engines, the most common outcome is no damage or slight damage to the engine fan or compressor blades. However, in more serious situations, blade damage can be sufficient enough to cause increasing engine vibrations, high exhaust temperatures, compressor stalls, engine fires or catastrophic failures. There was one such event where a rear fuselage-mounted engine on an executive jet was ripped from its mounting following a collision with a pelican.

Birds involved in engine ingestions are frequently flocking birds, increasing the possibility of damage to more than one engine. Another interesting occurrence is that some engines may have the airflow choked off by bird remains and quit running, but no damage occurs.

The most critical engine ingestion scenario is a single or multiple engine ingestion causing a power loss on takeoff. During this critical phase of flight, it is essential that the pilot properly recognize the emergency situation and perform proper engine-out or crash landing emergency procedures.

Pilots are encouraged to consider the following bird hazard checklist:

1. Review information in the NOTAMS and the Airport/Facility Directory about your departure and destination airport.

2. Flight plan at an altitude above 3,000 feet; the higher the better.

3. Avoid overflight of national wild-life refuges.

4. Flight plan to avoid flying along rivers or shorelines in the fall and spring. Birds frequently follow these natural terrain features during migration.

5. Thoroughly brief emergency procedures before departure, including those procedures to be followed if cockpit communications are lost.

6. During taxiing, watch for birds on the airport If birds are observed, request that airport management disperse the birds before takeoff.

7. Do not take off if flocks of birds are on or adjacent to the runway.

8. If an engine ingestion occurs on takeoff, abort if speed and remaining runway will allow. Inspect the engine before attempting a second takeoff. Several air carrier incidents have occurred where engine failures or high vibrations developed during the flight because of undetected engine damage.

9. If the takoff must be continued, properly identify the affected engine and execute emergency procedures.

10. If structural damage occurs or a windshield is penetrated, consider the need for a controllability check before attempting a landing.

11. If a windshield failure occurs, climb to slow the aircraft and reduce wind blast as necessary.

12. Use sunglasses or smoke goggles to reduce the effect of wind blast, precipitation, or debris.

13. If the windshield is cracked or delaminates, slow the aircraft and wear glasses or goggles to protect the eyes in case of a subsequent failure.

14. During cruise, watch for flocks of migratory birds and attempt to climb above observed flocks.

15. Use landing lights during descent. While there is no concrete evidence that birds see and avoid aircraft, the lights do aid the pilot.

16. If flocks of birds are encountered on descent or on an instrument approach, execute a missed approach, climb, and circle for a second approach. Since most flocks are distributed downward in the airspace, climbing will avoid the greatest number of birds. Birds will also migrate in waves across a wide front; therefore, a delay in the approach may result in clear airspace.

17. If high bird concentrations are encountered, slow the aircraft to minimize impact forces.

18. Upon landing, check the aircraft for bird strike damage.

19. Report all bird strikes on FAA Form 5200-7 (Bird Strike/Incident Report) which is available through the local General Aviation District Office, Flight Service Station, or Airport District Office.

20. Recognize that a bird is a ballistic object much like a bullet. Many pilots never experience a bird strike, and only one-third of all strikes cause damage; however, awareness of the problem can aid in the proper handling of an emergency situation.

These 20 tips are designed to prepare the pilot and crew for a bird strike. Improved pilot awareness of the potential hazard will result in a reduction in the number of serious bird strike incidents.

NOTE: Article was previously published in Alerts No. 68 dated March 1984.

ADF616073

BSCE 18/WP 29
Copenhagen, May 1986

MAY 86

BIRD HAZARDS
TO
LARGE TRANSPORT
AIRCRAFT ENGINES

PRESENTED BY: A T WEAVER
PRATT & WHITNEY
E HARTFORD CT

18TH MEETING
BIRD STRIKE COMMITTEE EUROPE
COPENHAGEN MAY 26-30, 1986

ATW P&W

THE ENGINE HAZARD

- FAN DAMAGE
- AIRFLOW DISRUPTION

SIGNIFICANT PARAMETERS

- MOMENTUM TRANSFER
- ROTATIONAL SPEED
- AIRCRAFT SPEED
- BIRD SIZE

MAY 86

HOW THE ENGINE RESPONDS

- o VARIES FROM NO EFFECT

  TO

  COMPLETE LOSS OF THRUST

PERCEPTION

- o COST
- o SAFETY

ATW P&W

SAFETY CONSIDERATIONS

- o THRUST LOSS AT TAKEOFF
- o PILOT WORKLOAD
- o MULTIPLE ENGINES

DESIGN AND CERTIFICATION STANDARDS

ENGINE

- o POUND AND A HALF BIRDS
- o PARTIAL POWER LOSS

AIRCRAFT

- o SINGLE ENGINE OUT AT T/O

NO ENGINE IS PERFECT

RISK

P1 X P1 X M = RISK FACTOR

WHERE P1 = PROBABILITY FOR SINGLE ENGINE OUT

M = PROBABILITY OF MULTIPLE ENGINE INVOLVEMENT

CORRECTIVE ACTION

REDUCE "P1"

- o LESS STREAMLINED COMPRESSOR PARTS

HIGHER FUEL CONSUMPTION

SIGNIFICANT COST TO OPERATOR

CORRECTIVE ACTION (cont.)

REDUCE "M"

- CONTROL BIRD FLOCKS ON AIRPORTS

- BIRD TRAFFIC CONTROL AT AIRPORTS

AIRPORT BIRD HAZARDS

- VERY FEW AIRPORTS HAVE AN EVERY DAY FLOCK PROBLEM

- MOST STRIKES ARE SINGLE BIRDS

- MANY "PROBLEM" AIRPORTS HAVE NON-FLOCKING BIRDS SUCH AS BLACK KITES

- AN AIRPORT BECOMES "UNSAFE" WHEN THE FLOCKS MOVE IN ON OR NEAR AN ACTIVE RUNWAY

- TRANSIENT FLOCKS USUALLY ARE NOT A SAFETY RISK UNTIL THEY SET DOWN ON THE AIRFIELD

- BAD WEATHER OR WEATHER CHANGES SHOULD BE THE FIRST WARNING THAT AN UNSAFE FLOCK HAZARD MAY BE PRESENT

SUMMARY

THE MANUFACTURERS ARE COMMITTED TO SIGNIFICANT IMPROVEMENTS

AIRPORT OPERATORS MUST FOLLOW SUIT

ADF616074

BIRD STRIKE COMMITTEE EUROPE

BSCE 18/WP 30
Copenhagen, May 1986

MILITARY AIRCRAFT
BIRD STRIKE ANALYSIS
1983-1984

Compiled by:

Squadron Leader C J Turner RAF
Inspectorate of Flight Safety (RAF)

London
March 1986

CC

MILITARY AIRCRAFT BIRDSTRIKE ANALYSIS - 1983/1984

INTRODUCTION

1. Five countries contributed data for the years 1983-84, a modest improvement in reporting over the previous 3 analyses. The following table shows a record of contributions to analyses since 1979:

	79	80	81	83	86
Belgian Air Force (BAF)	X	X	-	-	X
Royal Danish Air Force (RDAF)	X	X	X	X	X
French Air Force (EMAA)	(X)	-	-	-	-
German Air Force (GAF)	X	-	X	X	X
Royal Norwegian Air Force (RNoAF)	X	-	-	-	-
Royal Air Force (RAF)	X	X	X	X	X
Swedish Air Force (SAF)	X	-	X	X	X
United States Air Force (Europe) (USAF(E))	(X)	X	-	-	-
Total	6	4	4	4	5

2. Those contributions indicated as (X) denote that they were in an unusable format. One of the contributions for this report contained insufficient data to be included in Tables 7A, Effect of Strike which are, therefore, based on returns from 4 countries.

3. The small number of contributions, when compared with the number of countries participating in BSCE, may indicate that the usefulness of this report in its present format is in doubt.

BIRD SPECIES

4. Analysis of Tables 3 shows that the birds most commonly involved in strikes are Gull sp, Lapwing, Hirundinidae and Columbiformes. Annex A shows the trends for these birds from 1978-84. Both Lapwings and Gulls show a progressive decline from 1980-83 but this trend has been reversed in 1984. Hirundinidae have been increasingly involved in strikes up to 1982 and remained at about the same percentage for the next 2 years. In contrast, the percentage of strikes involving Columbiformes has varied over the years but shows a marked decrease in 1984 compared with previous years.

5. Tables 3, for the first time, contain details of those strikes which caused damage for each bird type. The birds identified in the previous paragraph are responsible for considerable damage, the heavier birds more than the lighter Hirundinidae. Also of note, with fewer strikes but a high proportion of damaging strikes, is the Buzzard, the trend for which is also shown at Annex A. It is evident that the heavier birds are more likely to cause damage, for example, Gull strikes in 1983-84 total 326 with 167 causing damage;

Skylarks were struck 67 times during the same period but only 3 caused damage.

6. An average of 43% of birds involved in strikes were identified during 1977-80. In 1981 the percentage fell to 30%. From 1982-84 an average of 39% were identified.

PART OF AIRCRAFT STRUCK AND EFFECTS

7. Four aircraft were lost in 1983-84. All were as a result of bird ingestion causing loss of engine power. All crew injuries involved with these losses were as a result of ejection. A further major injury was caused to a pilot when a Mallard penetrated a windscreen causing a major eye injury. The aircraft was recovered by the pilot, aided by the navigator.

8. Of the parts of the aircraft struck, engines showed a significant increase between 1979-82 but this levelled off in 1983 and reduced in 1984. This is illustrated at Annex B. Reported premature single engine changes over the same period varied significantly and did not follow the trends in single engine strikes. Also at Annex B is the percentage of windscreens struck, in 1984 at its lowest level since 1979. But over the period 1979-84 there is no definable improvement in the ratio between windscreens struck and windscreens cracked/broken. Reported damage of a minor nature, dents, continued to rise. More major damage, illustrated by structural deformation has, after peaking in 1981, recovered to close to the levels of 1979. Birdstrikes causing no damage continued, as in past years, to be about ⅔ of the totals reported.

TABLE 3 - BIRD SPECIES

1983

COMMON NAME	LATIN NAME	AVERAGE WEIGHT	CATEGORY	STRIKES (DAMAGE)	% BASED ON 668
Gull (Various)	Laridae	120-1690	B	89(50)	13.3
Swift	Apus apus	41	A	61(16)	9.1
Lapwing	Vanellus vanellus	215	B	49(16)	7.3
Swallow/Martin	Hirundinidae	13-19	A	44(5)	6.5
Skylark	Alauda arvensis	39	A	39(2)	5.8
Pigeons (Various)	Columbidae	40-465	A/B	36(17)	5.4
Passeriformes	-	6-1105	A/B	30(8)	4.5
Herring Gull	Larus argentatus	1020	B	23(15)	3.4
Woodpigeon	Columba palumbus	465	B	21(11)	3.1
Starling	Sturnis vulgaris	80	A	20(7)	3.0
Chaffinch	Fringilla colebs	23	A	20(5)	3.0
Racing Pigeon	Columba livia var	393	B	19(9)	2.8
Black-headed Gull	Larus ridibundus	275	B	19(4)	2.8
Buzzard	Buteo buteo	800	B	15(13)	2.2
Crow (Various)	Corvidae	234-1105	B	15(9)	2.2
Common Gull	Larus canus	420	B	12(2)	1.8
House Martin	Delichon urbica	17	A	10(1)	1.5
Wader	-	22-770	A/B	10(5)	1.5
Buzzard (Various)	Buteo sp	785-1350	B	10(5)	1.5
Sparrow	Passer sp	20-32	A	8(0)	1.2
Kestrel	Falco tinnunculus	204	B	7(1)	1.0
Fieldfare	Turdus pilaris	99	A	6(3)	0.9
Rook	Corvus frugilegus	430	B	6(2)	0.9
Redpoll	Carduelis flammea	12	A	5(1)	0.7
Thrush	Turdidae	67-131	A/B	5(1)	0.7
Oystercatcher	Haematopus ostralegus	500	B	5(2)	0.7
Redwing	Turdus iliacus	67	A	4(1)	0.6
Mallard	Anas platyrhynchos	1080	B	4(3)	0.6
Duck	Antidae	324-2040	B/C	4(4)	0.6
Partridge	Perdix perdix	400	B	3(0)	0.4
Golden Plover	Pluvialis apricaria	185	B	3(3)	0.4
Song Thrush	Turdus philomelos	73	A	2(1)	0.3
Lark (Various)	Alaudidae	21-60	A	2(0)	0.3
Greenfinch	Carduelis chloris	29	A	2(0)	0.3
Yellowhammer	Emberica citrinella	27	A	2(0)	0.3
Pied Wagtail	Motacilla alba	23	A	2(0)	0.3
Great Tit	Parus major	19	A	2(0)	0.3
Meadow Pipit	Anthus pratenisis	18	A	2(0)	0.3
Siskin	Carduelis spinus	14	A	2(1)	0.3
Plover	Charadriidae	34-280	A/B	2(1)	0.3
Falcon	Falconidae	105-1300	A/B	2(1)	0.3
Great B-backed Gull	Larus marinus	1690	B	2(2)	0.3
Grey Heron	Ardea cinerea	1500	B	2(1)	0.3
Hawk	Accipitridae	150-1026	B	2(0)	0.3
Grey Plover	Pluvialis squatarola	200	B	2(1)	0.3
Sparrowhawk	Accipiter nisus	190	B	2(0)	0.3
Snipe	Gallinago gallinago	125	B	2(0)	0.3
Greylag Goose	Anser anser	3325	C	2(2)	0.3
Gannet	Sula bassana	2900	C	2(2)	0.3
Blackbird	Turdus merula	106	A	1(0)	0.1
Cuckoo	Cuculus canorus	106	A	1(1)	0.1
Snow Bunting	Plectrophenax nivalis	35	A	1(0)	0.1
Brambling	Fringilla montifringilla	24	A	1(1)	0.1
Hedge Sparrow	Prunella modularis	21	A	1(0)	0.1

COMMON NAME	LATIN NAME	AVERAGE WEIGHT	CATEGORY	STRIKES (DAMAGE)	% BASED ON 668
Linnet	Carduelis cannabina	19	A	1(0)	0.1
Robin	Erithacus rubecula	18	A	1(0)	0.1
Coal Tit	Parus ater	9	A	1(0)	0.1
Tern	Sternus sp	45-570	A/B	1(0)	0.1
Pheasant	Phasianus colchicus	1100	B	1(0)	0.1
Kite	Milvus sp	240-1020	B	1(0)	0.1
Pintail	Anas acuta	840	B	1(1)	0.1
Goldeneye	Bucephala clangula	830	B	1(1)	0.1
Honey Buzzard	Pernis apivorus	785	B	1(1)	0.1
Marsh Harrier	Circus aeruginosus	630	B	1(0)	0.1
Hooded Crow	Corvus corone	530	B	1(0)	0.1
R-legged Partridge	Alectoris rufa	450	B	1(1)	0.1
Kittiwake	Rissa tridactyla	390	B	1(1)	0.1
Cattle Egret	Bubulcus ibis	345	B	1(1)	0.1
Woodcock	Scolopax rusticola	304	B	1(0)	0.1
L-eared Owl	Asio otus	273	B	1(1)	0.1
Jackdaw	Corvus monedula	234	B	1(1)	0.1
Magpie	Pica pica	220	B	1(1)	0.1
Ruff	Philomachus pugnax	139	B	1(0)	0.1
Turnstone	Arenaria interpres	112	B	1(0)	0.1
Owl	Strigiforme	66-2813	A-C	1(1)	0.1
Canada Goose	Branta canadensis	3600	C	1(1)	0.1
Cormorant	Phalacrocorax carbo	2430	C	1(0)	0.1
Goose	Anser/Branter sp	324-10K	B-D	1(1)	0.1
Vulture	Accipitridae	1880-9360	C/D	1(1)	0.1
Unknown				1065	
Total				1733	97.6

Notes:

3.1 Bird weights and Latin names can be obtained from Average Bird Weights by T Brough, July 1983. Unless there is positive evidence to the contrary the AVERAGE weight should be assumed.

3.2 The bird Categories, based on current Civil Airworthiness requirements are:

CAT A below .11kg (¼lb)
CAT B .11kg to 1.81kg (¼ to 4lb)
CAT C over 1.81kg to 3.63kg (4lb to 8lb)
CAT D over 3.63kg (8lb)

3.3 Those birds not positively identified should be tabled as unknown.

3.4 Large (Cat C or D) birds are often not positively identified, but the Category these are assumed to be in should be stated.

3.5 Percentages should be based on the total of identified birds.

3.6 Table 3 could be repeated restricted to own country only.

TABLE 7 PART OF AIRCRAFT STRUCK 1983

PART	WEIGHT UNKNOWN	CAT A	CAT B	CAT C & D	TOTAL	% BASED ON 1578
Nose (excluding radome and windscreen)	103	17	47	-	167	9.6
Radome	77	12	32	-	121	7.0
Windscreen	230	40	43	-	313	18.0
Fuselage (excluding the above)	189	40	80	3	312	18.0
Engine:-						
1 engine struck	225	80	99	1	405	23.3
2 out of 3 struck	-	-	-	-	-	-
2 out of 4 struck	-	-	-	-	-	-
3 out of 4 struck	-	-	-	-	-	-
all struck (on multi-engined aircraft)	-	-	7	1	8	0.5
Wing + Air Intakes	106	22	82	3	213	12.3
Rotor/Propeller	21	8	13	-	42	2.4
Landing Gear	27	12	20	1	60	3.5
Empennage	20	2	14	2	38	2.2
Underwing Stores/Tanks	37	4	16	-	57	3.3
Part Unknown	66	8	26	-	100	-
TOTAL	1101	245	479	11	1836	100.1

NOTES:-

7.1 The Total in Table 7 and 7A may be higher than other tables, as one bird can strike several parts.

7.2 The percentages should be based on incidents where the part struck is known.

7.3 Multiple strikes should be counted as one strike unless, for example, both wings or both landing gears are struck, when two incidents should be recorded.

EFFECT	WEIGHT UNKNOWN	CAT A	CAT B	CAT C	CAT D	TOTAL	% BASED ON 1474
Loss of Aircraft	1	-	1	-	-	2	0.1
Flight Crew Injury							
Major	1	-	1	-	-	2	0.1
Minor	1	-	1	-	-	2	0.1
Slight							
Premature Engine Change:-							
on single engined A/C	26	3	16	1	-	46	2.7
1 on a 2 engined A/C	18	2	19	-	-	39	2.3
1 on a 3 engined A/C	-	-	-	-	-	-	-
1 on a 4 engined A/C	1	-	-	-	-	1	0.1
2 on a 3 engined A/C	-	-	-	-	-	-	-
2 on a 4 engined A/C	-	-	-	-	-	-	-
3 on a 4 engined A/C	-	-	-	-	-	-	-
all engines on a multi	-	-	1	-	-	1	0.1
Windscreen Cracked/Broken	26	3	9	-	-	38	2.2
Radome Changed	15	2	13	-	-	30	1.8
Deformed Structure	17	2	16	-	-	35	2.1
Skin Torn	40	9	25	4	1	79	4.7
Skin Dented	114	18	79	1	2	214	12.7
Propeller/Rotor Damaged	1	1	-	-	-	2	0.1
Aircraft System Lost	3	-	1	2	1	7	0.4
Underwing Stores/Tanks Damaged	25	2	11	-	-	38	2.2
Miscellaneous	19	4	18	1	-	42	2.5
Nil Damage	730	184	198	1	-	1113	65.8
Unknown	6	-	4	-	-	10	-
TOTAL	1044	230	413	10	4	1701	100

NOTES:

7A.1 Multiple strikes should be counted as one strike unless, for example, both wings are damaged or both windscreens are broken, in which case two incidents should be recorded.

7A.2 Definition of Injury requiring medical treatment:
Major - causing absence of 21 days or over.
Minor - causing absence of 7 to 21 days.
Slight - injury not in above 2 categories.

7A.3 Injuries as a consequence of a strike, eg ejection injuries should be included.

7A.4 Aircraft system lost includes, for example, electrical, hydraulic, brake, air conditioning, de-icing.

TABLE 3 - BIRD SPECIES 1984

COMMON NAME	LATIN NAME	AVERAGE WEIGHT	CATEGORY	STRIKES (DAMAGE)	% BASED ON 647
Gull (Various)	Laridae	120-1690	B	107(64)	16.5
Swift	Apus apus	41	A	56(16)	8.7
Lapwing	Vanellus venellus	215	B	55(15)	8.5
Swallow/Martin	Hirundinidae	13-19	A	44(9)	6.8
Black-headed Gull	Larus ridibundus	275	B	41(8)	6.3
Passeriforme	-	6-1105	A/B	36(10)	5.6
Starling	Sturnis vulgaris	80	A	28(8)	4.3
Skylark	Alauda arvensis	39	A	28(1)	4.3
Pigeons (Various)	Columbidae	40-465	A/B	23(16)	3.6
Herring Gull	Larus argentatus	1020	B	17(11)	2.6
Buzzard	Buteo buteo	800	B	17(13)	2.6
Woodpigeon	Columba palumbus	465	B	14(7)	2.2
House Martin	Delichon urbica	17	A	13(1)	2.0
Common Gull	Larus canus	420	B	13(8)	2.0
Buzzard (Various)	Buteo sp	785-1350	B	11(4)	1.7
Racing Pigeon	Columba livia var	393	B	11(4)	1.7
Thrush	Turdidae	67-131	A/B	8(3)	1.2
Partridge	Perdix perdix	400	B	8(2)	1.2
Redwing	Turdus iliacus	67	A	6(1)	0.9
Meadow Pipit	Arthus pratensis	18	A	6(2)	0.9
Fieldfare	Turdus pilaris	99	A	5(1)	0.8
Kestrel	Falco tinnunculus	204	B	5(1)	0.8
Rook	Corvus frugilegus	430	B	5(2)	0.8
Sparrow	Passer sp	20-32	A	4(1)	0.6
Chaffinch	Fringilla colebs	23	A	4(1)	0.6
Wader	-	22-770	A/B	4(4)	0.6
Golden Plover	Pluvialis apricaria	185	B	4(3)	0.6
Brambling	Fringilla montifringilla	24	A	3(0)	0.5
Linnet	Carduelis cannabina	19	A	3(0)	0.5
Sand Martin	Delichon urbica	17	A	3(0)	0.5
Plover	Charadriidae	34-280	A/B	3(1)	0.5
Crow (Various)	Corvidae	234-1105	B	3(3)	0.5
Pheasant	Phasianus colchicus	1100	B	3(1)	0.5
Oystercatcher	Haematopus ostralegus	500	B	3(0)	0.5
Sparrowhawk	Accipiter risus	190	B	3(2)	0.5
Dunlin	Calidris alpina	50	A	2(1)	0.3
Lark (Various)	Alaudidae	21-60	A	2(0)	0.3
Yellowhammer	Emberica citrinella	27	A	2(0)	0.3
Owl	Strigiforme	66-2813	A-C	2(0)	0.3
Great B-backed Gull	Larus marinus	1690	B	2(2)	0.3
Kite	Milvus sp	240-1020	B	2(1)	0.3
Mallard	Anas platyrynchos	1080	B	2(2)	0.3
Goose	Anser/Branter sp	324-10K	B-D	2(1)	0.3
Stork	Ciconia ciconia	3400	C	2(2)	0.3
G spotted Woodpecker	Dendrocopos major	80	A	1(0)	0.2
Song Thrush	Turdus philomelos	73	A	1(0)	0.2
Shrike	Lanius sp	27-62	A	1(0)	0.2
Ringed Plover	Charadrius hiaticula	54	A	1(0)	0.2
Sandpiper	Actitis hypoleucos	45	A	1(1)	0.2
Greenfinch	Carduelis chloris	29	A	1(0)	0.2
Pied Wagtail	Motacilla alba	23	A	1(0)	0.2
Tree Pipit	Anthus trivialis	22	A	1(0)	0.2
Dunnock	Prunella modularis	21	A	1(0)	0.2
Yellow Wagtail	Motacilla flava	17	A	1(0)	0.2

COMMON NAME	LATIN NAME	AVERAGE WEIGHT	CATEGORY	STRIKES (DAMAGE)	% BASED ON 647
Black Redstart	Phoenicurus ochruros	16	A	1(0)	0.2
Lesser Whitethroat	Sylvia communis	12	A	1(0)	0.2
Falcon	Falconidae	105-1300	A/B	1(0)	0.2
Tern	Sternus sp	45-570	A/B	1(0)	0.2
Grey Heron	Ardea cincerea	1500	B	1(1)	0.2
Rough-legged Buzzard	Buteo lagopus	985	B	1(0)	0.2
Goldeneye	Bucephela clangula	830	B	1(1)	0.2
Lesser B-backed Gull	Larus fuscus	820	B	1(1)	0.2
Curlew	Numerius arquata	770	B	1(1)	0.2
Carrion Crow	Corvus corone	530	B	1(1)	0.2
Red-legged Partridge	Alectoris rufa	450	B	1(0)	0.2
Puffin	Fratercula arctica	425	B	1(0)	0.2
Woodcock	Scolopax rusticola	304	B	1(1)	0.2
Moorhen	Gallinula chloropus	300	B	1(0)	0.2
L-eared Owl	Asio otus	273	B	1(0)	0.2
Red-footed Falcon	Falco vespertinus	155	B	1(0)	0.2
Snipe	Gallinago gallinago	125	B	1(1)	0.2
Duck	Anatidae	324-2040	B/C	1(1)	0.2
Greylag Goose	Anser anser	3325	C	1(1)	0.2
Gannet	Sula bassana	2900	C	1(0)	0.2
Cormorant	Phalacrocorax carbo	2430	C	1(1)	0.2
S Giant Petrel	Macronectes giganteus	4400	D	1(1)	0.2
Unknown				907	
Total				1554	101.5

Notes:

3.1 Bird weights and Latin names can be obtained from Average Bird Weights by T Brough, July 1983. Unless there is positive evidence to the contrary the AVERAGE weight should be assumed.

3.2 The bird Categories, based on current Civil Airworthiness requirements are:

CAT A below .11kg ($\frac{1}{4}$lb)
CAT B .11kg to 1.81kg ($\frac{1}{4}$ to 4lb)
CAT C over 1.81kg to 3.63kg (4lb to 8lb)
CAT D over 3.63kg (8lb)

3.3 Those birds not positively identified should be tabled as unknown.

3.4 Large (Cat C or D) birds are often not positively identified, but the Category these are assumed to be in should be stated.

3.5 Percentages should be based on the total of identified birds.

3.6 Table 3 could be repeated restricted to own country only.

TABLE 7 PART OF AIRCRAFT STRUCK 1984

PART	WEIGHT UNKNOWN	CAT A	CAT B	CAT C & D	TOTAL	% BASED ON 1578
Nose (excluding radome and windscreen)	118	19	48	-	185	11.7
Radome	74	8	27	-	109	6.9
Windscreen	139	50	35	-	224	14.2
Fuselage (excluding the above)	148	36	67	3	254	16.1
Engine:-						
1 engine struck	171	52	100	2	325	20.6
2 out of 3 struck	-	-	-	-	-	-
2 out of 4 struck	-	-	2	-	2	0.1
3 out of 4 struck	-	-	-	-	-	-
all struck (on multi-engined aircraft)	2	2	3	-	7	0.4
Wing + Air Intakes	126	36	80	1	243	15.4
Rotor/Propeller	16	4	18	-	38	2.4
Landing Gear	33	11	36	-	80	5.1
Empennage	24	4	25	-	53	3.4
Underwing Stores/Tanks	34	4	19	1	58	3.8
Part Unknown	43	13	28	-	84	-
TOTAL	928	239	488	7	1662	100.1

NOTES:-

7.1 The Total in Table 7 and 7A may be higher than other tables, as one bird can strike several parts.

7.2 The percentages should be based on incidents where the part struck is known.

7.3 Multiple strikes should be counted as one strike unless, for example, both wings or both landing gears are struck, when two incidents should be recorded.

EFFECT	WEIGHT UNKNOWN	CAT A	CAT B	CAT C	CAT D	TOTAL	% BASED ON 1474
Loss of Aircraft	-	-	1	-	1	2	0.1
Flight Crew Injury							
Major	-	-	-	-	1	1	0.1
Minor	-	-	-	-	-	-	-
Slight	-	-	2	-	-	2	0.1
Premature Engine Change:-							
on single engined A/C	23	11	13	1	-	48	3.3
1 on a 2 engined A/C	16	3	20	-	-	39	2.6
1 on a 3 engined A/C	1	-	-	-	-	1	0.1
1 on a 4 engined A/C	1	1	1	-	-	3	0.2
2 on a 3 engined A/C	-	-	-	-	-	-	-
2 on a 4 engined A/C	-	-	-	-	-	-	-
3 on a 4 engined A/C	-	-	-	-	-	-	-
all engines on a multi	1	-	-	-	-	1	0.1
Windscreen Cracked/Broken	14	2	12	-	-	28	1.9
Radome Changed	15	2	9	-	-	26	1.8
Deformed Structure	21	1	10	-	-	32	2.2
Skin Torn	35	4	26	1	-	66	4.5
Skin Dented	98	21	83	1	1	204	13.8
Propeller/Rotor Damaged	3	1	3	-	-	7	0.5
Aircraft System Lost	4	1	-	-	-	5	0.3
Underwing Stores/Tanks Damaged	16	1	7	-	-	24	1.6
Miscellaneous	26	2	20	-	-	48	3.3
Nil Damage	575	176	195	-	-	946	64.2
Unknown	8	2	3	-	-	13	-
TOTAL	857	218	406	3	3	1487	100.7

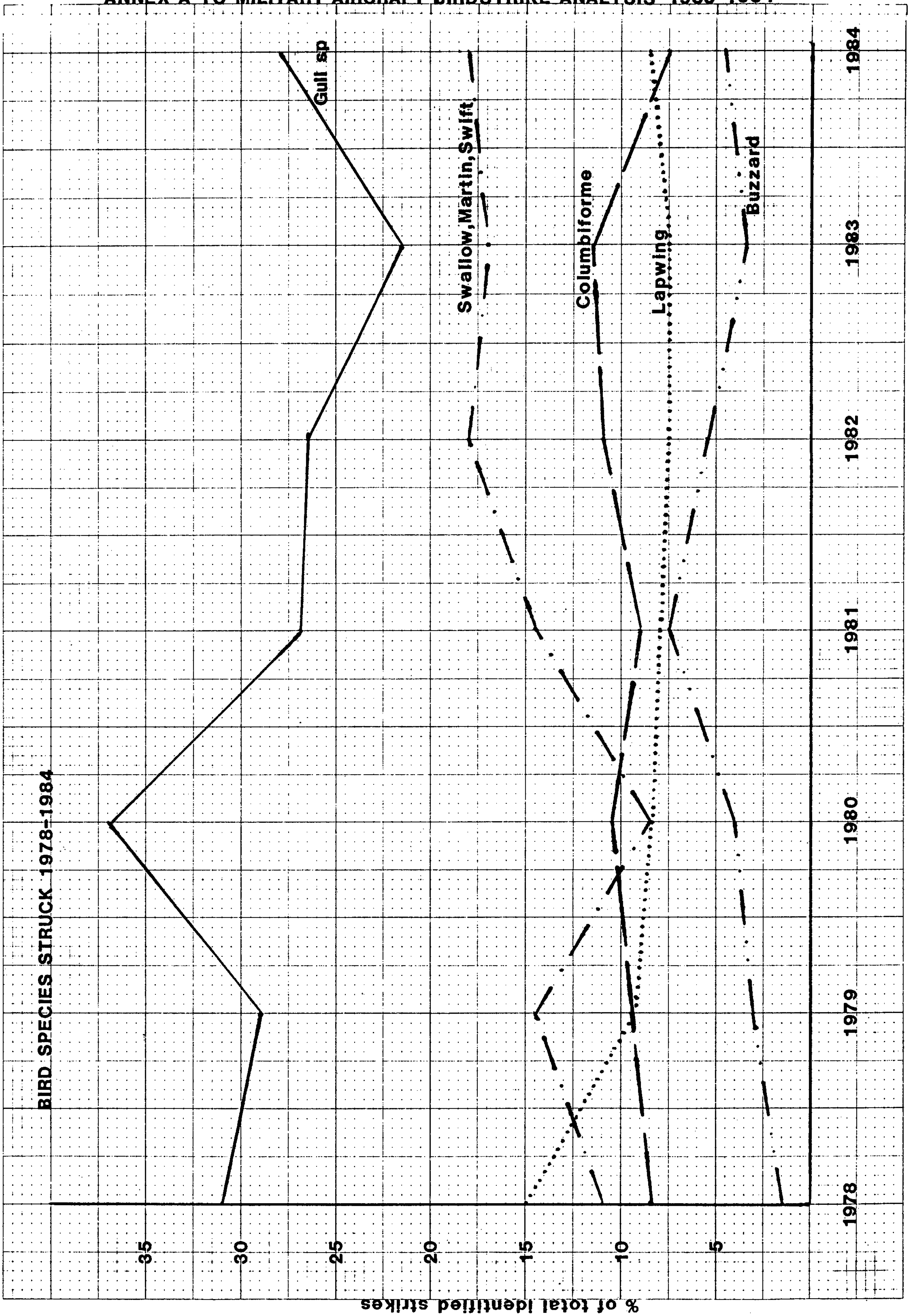
NOTES:

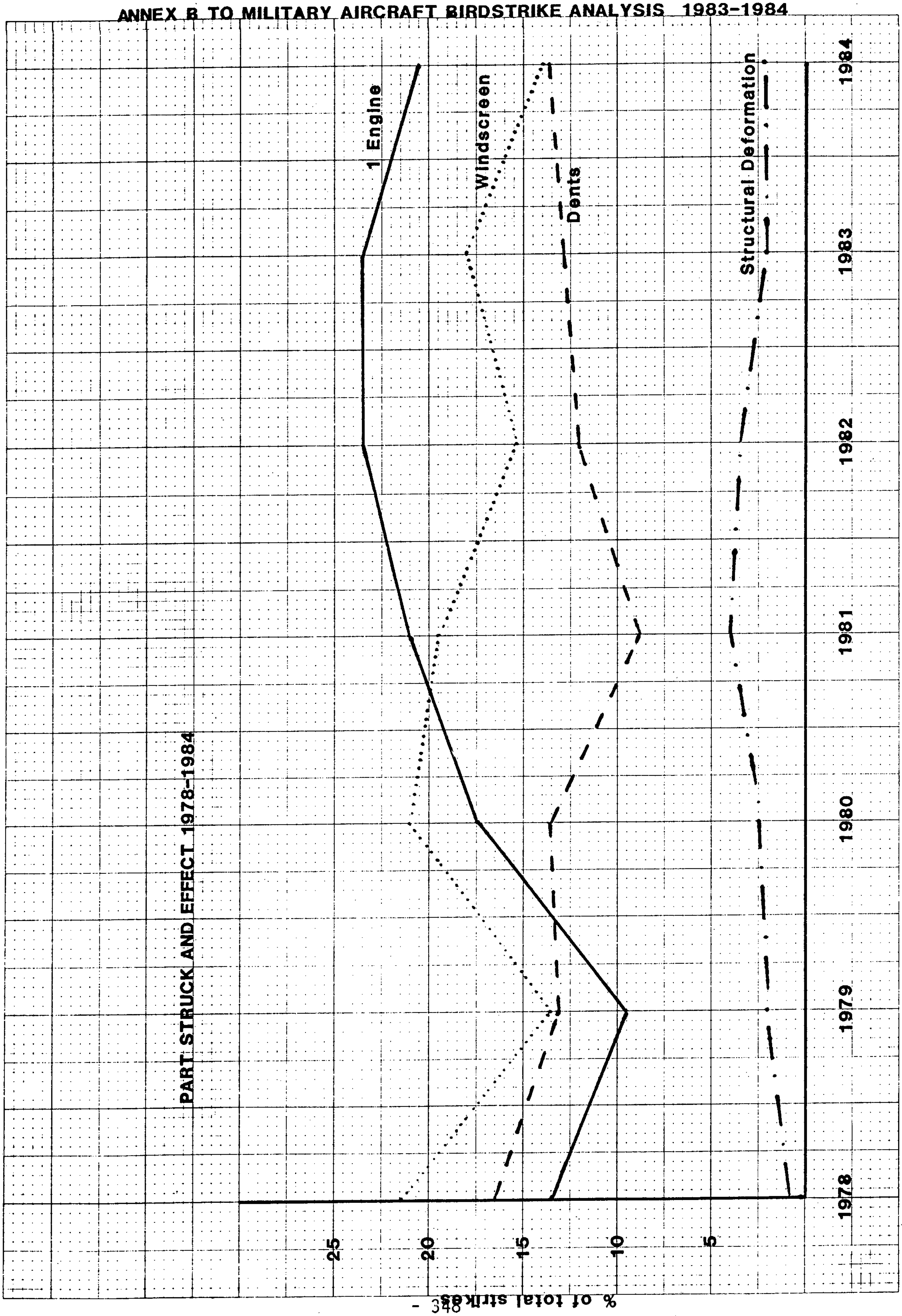
7A.1 Multiple strikes should be counted as one strike unless, for example, both wings are damaged or both windscreens are broken, in which case two incidents should be recorded.

7A.2 Definition of Injury requiring medical treatment:
Major - causing absence of 21 days or over.
Minor - causing absence of 7 to 21 days.
Slight - injury not in above 2 categories.

7A.3 Injuries as a consequence of a strike, eg ejection injuries should be included.

7A.4 Aircraft system lost includes, for example, electrical, hydraulic, brake, air conditioning, de-icing.


BIRD SPECIES STRUCK 1978-1984
Gull sp
Swallow,Martin,Swift
Columbiforme
Lapwing
Buzzard
1978
1979
1980
1981
1982
1983
1984
35
30
25
20
15
10
5
% of total identified strikes


PART STRUCK AND EFFECT 1978-1984
1 Engine
Windscreen
Dents
Structural Deformation
1978
1979
1980
1981
1982
1983
1984
25
20
15
10
5
% of total strikes

BSCE 18/WP 31
Copenhagen, May 1986

RESISTANCE OF WINDSCREEN TO BIRD IMPACT DURING COLD WEATHER

by Miss Christiane NEVEUX (S.T.P.A.)

A study on the behaviour of glass windscreen in case of bird impact, when there is no warming and cold weather, shows that there is no deterioration in bird impact resistance for glass windscreen with thin interlayers.

RESISTANCE OF WINDSCREEN TO BIRD IMPACT DURING COLD WEATHER

Introduction

The French S.T.P.A. sponsored since 1985 a study on the behaviour of no warming windscreens at low temperature during bird impact.

Test conditions

Several tests were done in C.E.A.T. with windows mounted on frame which is not representative of aircraft frame.

First shots were done at room temperature (about 10°C) to determine critical speed for each selected compositions of window.

Then shots were done on no-warming,cooled and same composition window. It was established that cooling window mounted on frame by carboxylic put on a window side was too long and few satisfying;so the windows were stocked in a freezer during more than 12 hours,then they were mounted as quickly as possible on the frame.The window's temperature at the shot instant was about −18°C.

Results

The following table gives the summary of tests with 4 pounds birds for glass window with different thickness of interlayers (P.V.B.)

Interlayer Thickness	Results	Conclusion
1mm/1,4mm/ 1mm	At room and low temperature perforation between 190 and 200 m/s	No significative difference
1mm/1,4mm/ 1mm	Limit speed at room temperature : 181 m/s at low temperature : 177 m/s	No significative difference
1mm/2mm/ 1mm/3mm	At room temperature important partial failure at 222 m/s At low temperature perforation between 207m/s and 222m/s	Very low difference,not easily evaluable
1mm/4mm	At room temperature perforation between 225m/s and 250m/s At low temperature important partial failure at 220 m/s	Decrease of perforation speed not exeeding 30m/s

Conclusion

The resistance decrease to bird impacts at low temperature for aircraft glass windows with inter layers in P.V.B. is

-negligible if the P.V.B. layers have thickness of 1,5mm maximum

-weak if there is P.V.B. layers of 4mm maximum;the dispersion of results can be partially explained by fabrication tolerances.

The present study shall be continued to establish a decreasing law at low temperature for the resistance to bird impacts of glass windows versus interlayer (P.V.B.) thickness.

ADF616076

BSCE 18/WP 32
Copenhagen, May 1986

Increase of Efficiency of the Mobile Bio-Acoustic System for Scaring Birds within the Airport Area

B. Efanov

The world aviation community has not so far obtained the universal "antibird" instrument, which is the evidence of the complexity of the bird strike prevention problem. At present one has to implement a whole series, of measures to decrease the aamount of bird strikes to aircraft.

Dispersal of birds from airfields by playing back the magnetic tape recordings of different birds' distress calls is being used in many countries for a long time with some success. We have tried to investigate the reasons which decrease the effectiveness of the bio-acoustic method and to work out the ways to improve the bird repellent signal effect.

As the result of the work conducted we came to the conclusion that the effect of the bio-acoustic bird scaring depends upon a number, of factors of technical, biological and administrative nature. With these factors being underestimated, the birds quickly get used to the broadcasted calls and as, the result the bio-acoustic technique becomes less effective.

The frequency range of sounds produced by certain birds is from 0.06 to 50 kHz. The vocal range of the absolute majority of bird species is from 0.2 to 12 kHz. The low threshold of bird hearing perception is 50 to 70 Hz, whereas the upper limit can be as high as 35 kHz. The maximum of the vocal energy spectrum of the most of birds is within the range of 2 to 8 kHz, which is substantially higher than that of the human speech energy spectrum. This fenomenon imposes essential limitations on the use of common broadcasting systems for the bird scaring purposes.

As the result of the research work carried out, the Soviet specialists have developed a mobile bio-acoustic system having the following specifications:

1. Nominal output power of the amplifier at the impedance of 8 OHM - 80 W,
2. Maximum output power - 140 W,
3. Efficiency at the nominal output power - 65%
   at the maximum output power - 82%,

4. Frequency range at the level of 3 dB - 0.3 - 18 kHz,

5. Effective frequency range with sound pressure having uneven frequncy of 15 dB (acoustic system) - 0.3 - 18 kHz,

6. Nominal acoustic power - 100 W,

7. Dimensions:

	acoustic system	-	530 x 240 x 270 mm,
	amplifier	-	310 x 190 x 105 mm,
	recorder	-	318 x 225 x 85 mm,

8. Mass:

	acoustic system	-	10,7 kg,
	amplifier	-	5.2 kg,
	recorder	-	3 kg.

Reasonable approach to the bio-acoustic technical requirements with due account to the bird cries spectrum characteristics made it possible to develop a kind of broadcasting system having sophisticated technical and economic characteristics.

Unlike other similar systems the power supply of the bio-acoustic system is provided by the vehicle battery with the voltage of 12.4 V and the minus lead grounded. The system needs no additional batteries. As far as the circuit voltage when the vehicle engine works may reach 15.5 V the system is equipped with a stabilizer. The system is also protected against shortenings, overloads, shifts of power supply from plus to minus and provided with the Built-in Control unit which allows to monitor its operation in the field without any additional control equipment.

The wide broadcasting frequency range is achieved by means of a double-band acoustic system with a separation frequency of 5 kHz. As the medium-frequency loudspeakers the system incorporates narrownecked horn heads with ~~xxxx~~ the cut exponential fiberglass horns, the shape of which changes smoothly from round to rectangular. High frequency heads have aluminium quasi-exponential horns consisting of external and enternal parts which are the protruded Vente bodies. Due to the implementation of narrownecked horn loudspeakers the system has a high electroacoustic efficiency resulting in high sound pressure which is necessary for the operation of the system within the airport area. Maximum sound pressure at the distance of 1 m along the acoustic axis when emitting the siren type signal is 136 dB. The voice signal broadcasting range of the system is more than 1 km.

The high intelligibility of speech and repellent sygnals is achieved by special treatment of these signals in the electric

circuit of the bio-acoustic system. This treatment is done by limiting the signal spectrum both at the hihg and low frequencies and by the introduction of frequency pre-distortions. Researches witness that within the airport area where the background noise level is substantially high it is reasonable to use specifically treated high level sygnals. For instance when repellent signals that had pre-distortions within the frequency range of 0.4 to 5 kHz with the positive amplitude-frequency slope of 3 dB/oct were broadcasted for the seagull-type bird congregation at the distance of 300 to 400 m, the disperse effect of such signals was more efficient. This kind of treatment of the bird calls recordings counterbalances the attenuation of high frequency components of these signals in the air.

The results of our preliminary study show that the low frequency limitation of the frequency range up to 400 Hz does not influence the signal efficiency, but makes it possible to substantially reduce the size of the amplifier and acoustic antennas.

Substantial increase of the bio-acoustic technique efficiency is provided by the appropriate choice of the repellent signal. Although the recordings of the "emergency-pain" cries produced by birds under simulated conditions do have the scaring effect, it is of a short-term nature. Birds, especially belonging to the local area, soon get used to these recorded signals. The most efficient calls are those recorded in the nature. These are the calls produced by birds when they are attacked by the bird of prey or when they unexpectedly get into a trap.

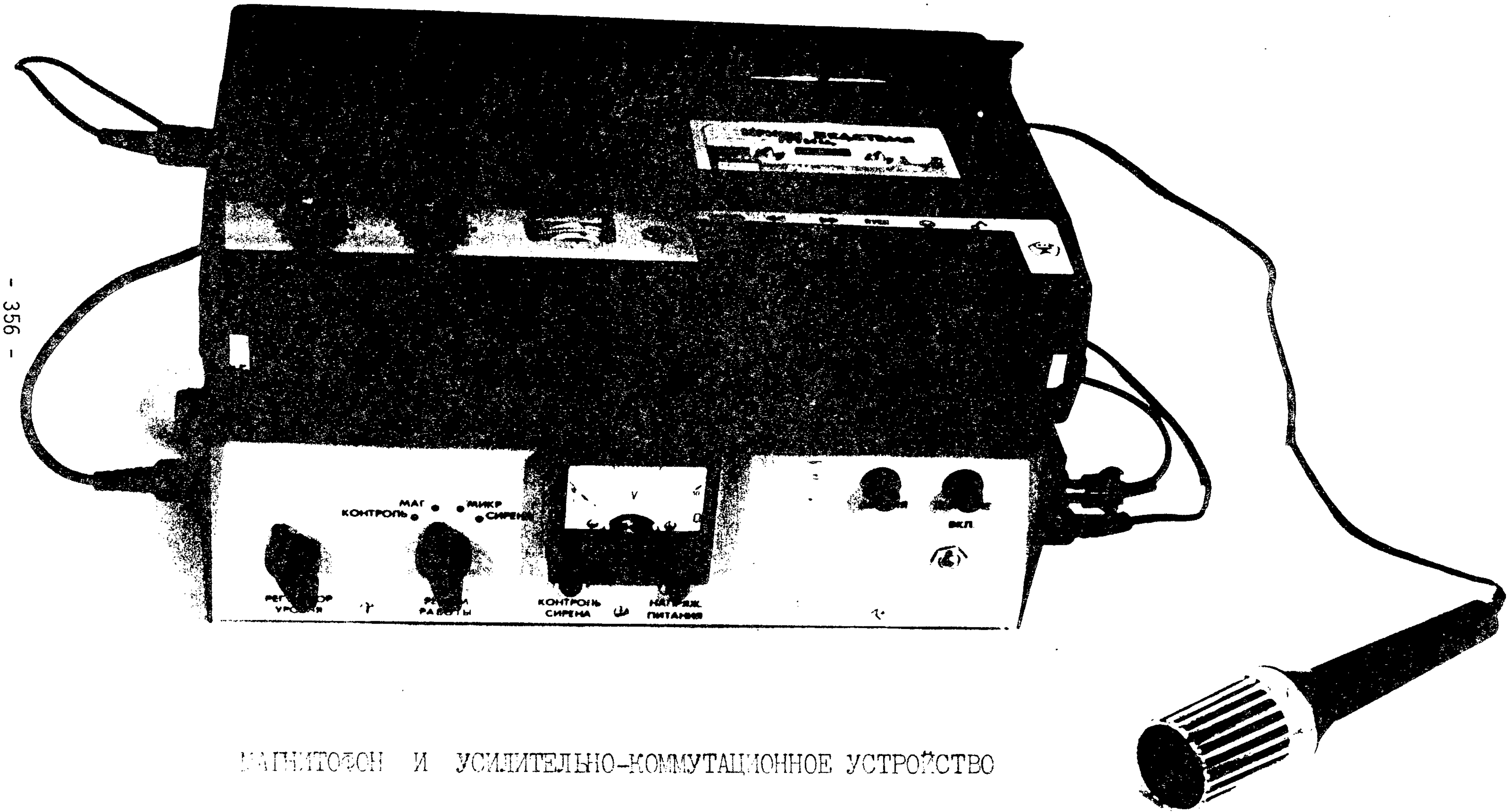
Furhher study of bird calls will enable the development of efficient scaring systems utilizing the synthesized calls.

It is a common observation that birds demonstrate the following response sequence to the transmitted repellent signal. They take off, fly up to the source of the sound, circle round and fly away or alight. We believe that this kind of bird response is normally observed only when a less efficient signal (mainly "emergency-pain" cry) is transmitted, when it is unintelligible or when birds become accustomed to the frequently transmitted signal.

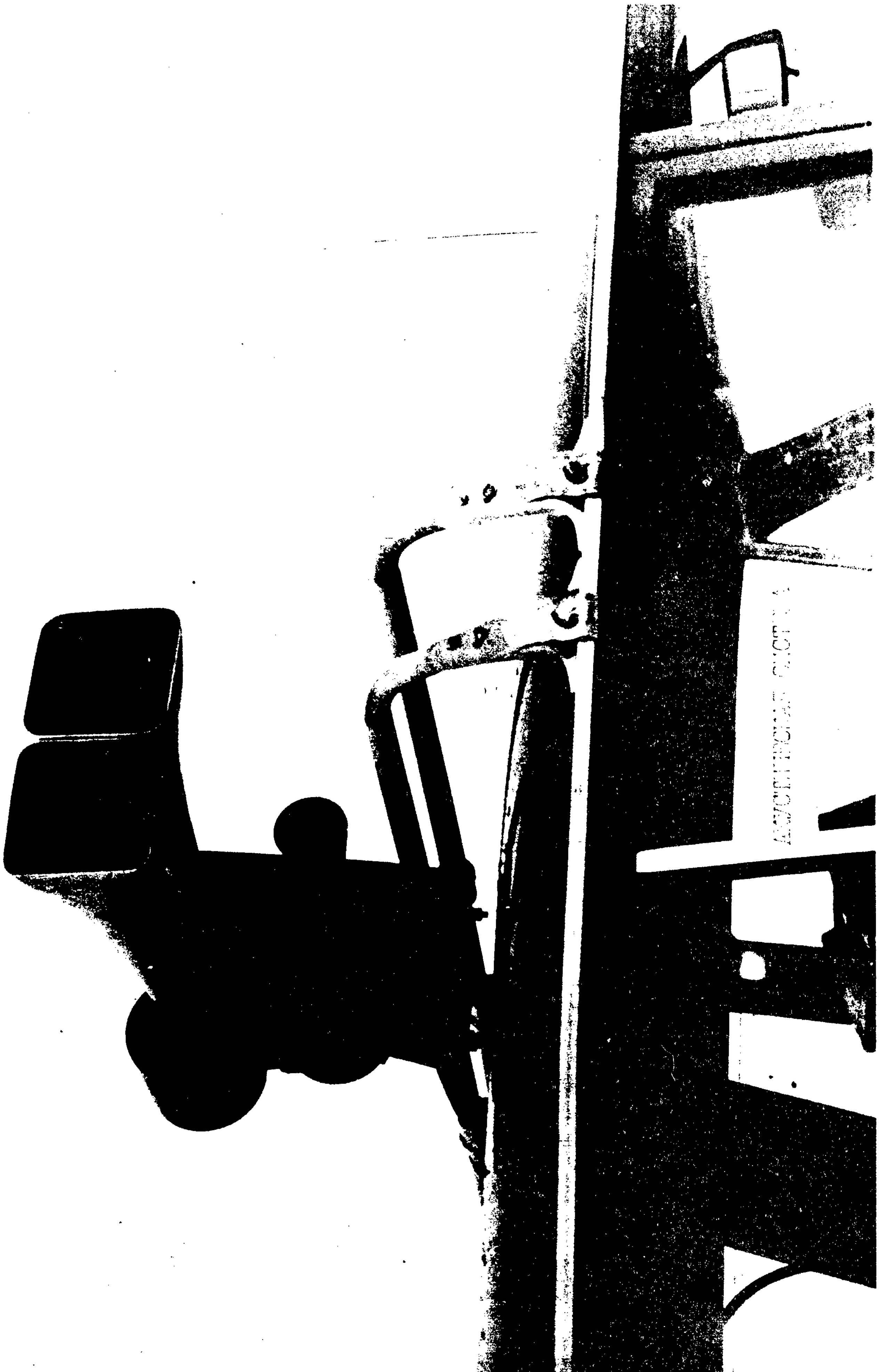
As far as the bio-acoustic method implies the natural response of birds to distress calls, it is quite necessary to accompany the broadcasting with the "real" danger (shell crackers)

as a support from time to time.

The bio-acoustic system was used not only to disperse birds from airfields. It was quite successfully utilized in cities to provide anti-bird protection of public buildings and historic monuments. The two-year operational experience proves high efficiency of the system.



МАГНИТОФОН И УСИЛИТЕЛЬНО-КОММУТАЦИОННОЕ УСТРОЙСТВО



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BSCE 18/ WP 33

COPENHAGEN MAY 1.986

TITLE STUDY STRUCTURE OF BIRD AND ECOSYSTEMS IN SPANISH AIRPORTS

AUTHOR JUAN RUIZ
PABLO MORERA

SERVICIO DE LABORATORIOS
SPANISH AIRPORT AUTHORITY

S U M M A R Y

THE RISK OF COLLISIONS WITH BIRDS IN AIRPORTS PRESENTS A COMPLEX PROBLEM WHICH IS OFTENTIMES DIFFICULT TO RESOLVE.

THE SPANISH AIRPORT AUTHORITY, AN AUTONOMOUS BODY WITHIN THE MINISTRY OF TRANSPORTATION, TOURISM AND COMMUNICATIONS, COMMISSIONED A STUDY LEAD BY THE TECHNICAL LABORATORIES AND THE ENVIRONMENTAL SECTION, TO DEFINE A GENERAL METHODOLOGY FOR THE STUDY OF BIRD PROBLEMS.

THE METHODOLOGY THUS ESTABLISHES, IS CURRENTLY BEING EMPLOYED IN THE AIRPORTS OF PALMA DE MALLORCA, MENORCA, IBIZA, TENERIFE/SUR, BARCELONA AND SANTANDER. THE PURPOSE OF THIS REPORT IS TO REVIEW THE MAIN FEATURES OF THE AFOREMENTIONED STUDIES AND THE METHODS APPLIED, AND TO ILLUSTRATE THE RESULTS OBTAINED DURING THE FIRST MONTH OF SAMPLING VIA SEVERAL REALLIFE EXAMPLES.

<u>TABLE OF CONTENTS</u>

1. INTRODUCTION

The risk of collisions with birds in airports presents a complex problem which is oftentimes difficult to resolve. The bulk of all precautionary measures applied are rarely based on in-depth knowledge of bird populations, and therefore, more often than not, merely reduce the influx of certain species. Moreover, despite the economic cost involved, many of these dissuasive measures have not fulfilled initial expectations, either because the presence of bird populations in airport zones is due to circumstances not related to the airport itself (migratory routes, feeding grounds, etc.), or because the ecosystems surrounding the airport greatly predetermine the species and population densities found.

Bearing in mind this situation, the Spanish Airport Authority, an autonomous body within the Ministry of Transportation, Tourism and Communications, commissioned a study to evaluate the status of the Vigo Airport (Northwest of Spain), with two objectives in mind: first, to define a general methodology for the study of bird populations in Spanish airports, and second, to reduce the risk of collisions. The methodology thus established is currently being employed in the airports of Palma de Mallorca, Menorca, Ibiza, Tenerife-Sur, Barcelona and Santander. The purpose of this report is (i) to review the main features of the aforementioned studies and the methods applied, and (ii) to illustrate the results obtained during the first month of sampling via several real-life examples.

2. STUDY STRUCTURE

The general framework of the study is summarized in fig. 1. First of all, an analysis of the particular features of each airport is carried out to define: siting, distribution of runways and buildings, vegetation (mainly structure), utilization, etc. Thereafter, surrounding areas which may have an impact on the bird populations in airports are then identified: resting spots, feeding grounds, breeding areas, and roosting places. This information is then used as a basis for sample design. Sampling takes place throughout the year on a monthly basis.

Samples have been classified under six separate headings, according to the different methodologies selected:

- Stable bird populations in the ecosystems in and around the airport site,
- Bird flows,
- Birds located on runways,
- Birds from outside areas which affect the airport,
- Roosting grounds,
- Additional information (dead specimens and data gathered prior to the study).

Since sampling of bird populations takes place year round, and the characteristics of air traffic in each particular airport are identified, two important features may be defined upon completion of the sampling campaign. First, numerical population evolution and behaviour can be determined and the influence of certain outside conditioning factors viewed, and second, specific risk patterns can be evaluated as a function of: density, weight, flight patterns, flock size, etc.

Finally, safety measures designed to reduce these risks are proposed, i.e. modification of vegetation around the air-

FIGURE 1

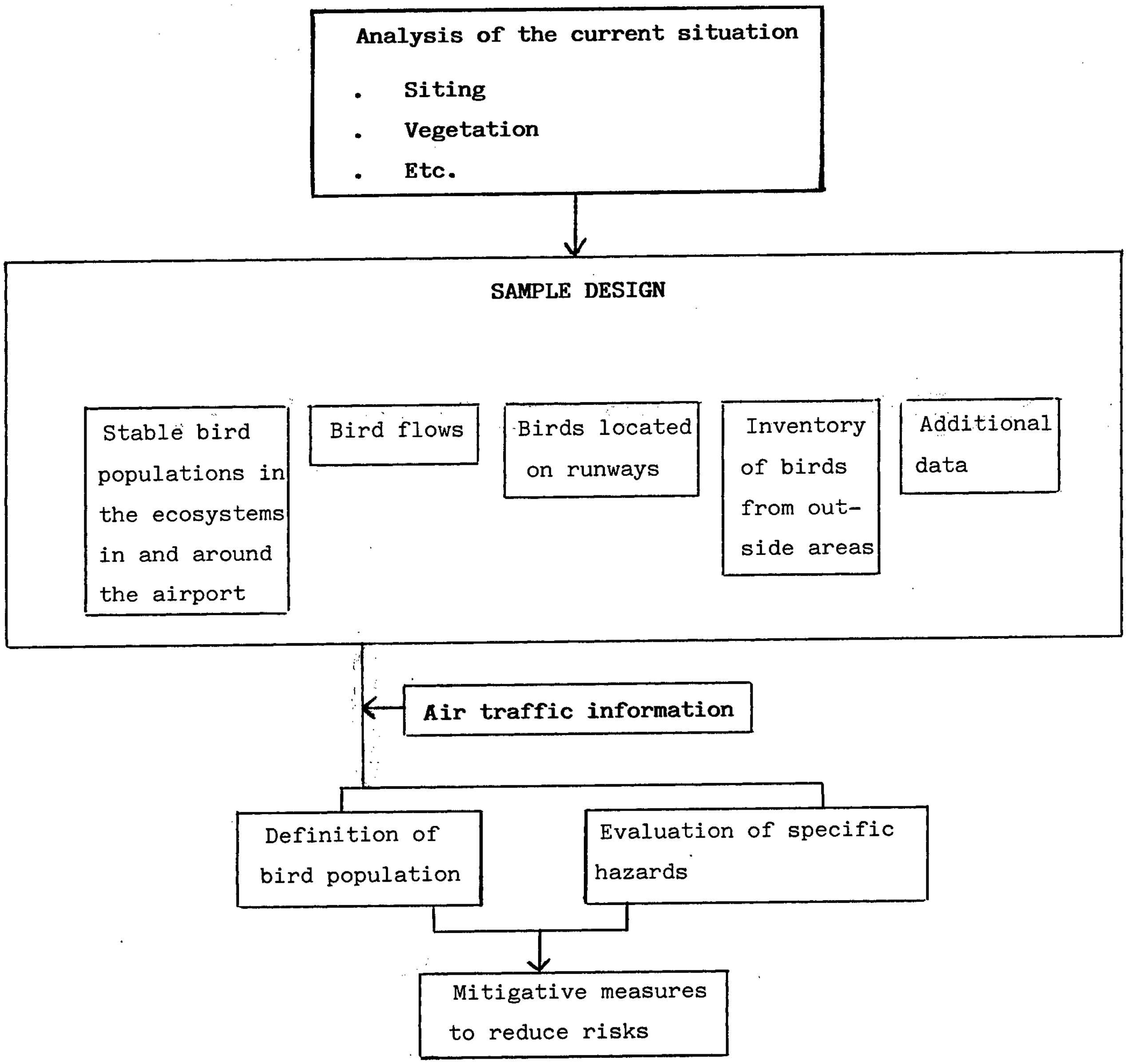


Fig. 1. General survey structure

port, dissuasive practices (different types of equipment, creation of alternative homing grounds, removal or remodeling of certain external sites, etc.).

The airport survey is currently in its fourth month of sampling, and accordingly, the data presented herein is as of yet incomplete and cannot offer definitive findings. The following highlights the methods employed for each type of sampling campaign, and offers a preliminary overview of some results.

3. STABLE BIRD POPULATIONS IN THE ECOSYSTEMS IN AND AROUND THE AIRPORT

As the heading itself suggests, this category includes populations stabilized in the ecosystems in and around the airport. As far as their potential menace of collision, these birds do not appear to present excessive risks, but that is not to say that they are harmless. Indeed, certain species could imperil air traffic due to their size and population densities, i.e. Vanellus vanellus or Pluvialis apricaria. In some airports, both have settled on airport premises and may form flocks of hundreds of individuals, cross runways at low altitudes and thereby create a potential air traffic hazard. Moreover, by recording the species living within a given vegetation structure, plans may be drawn up to introduce vegetation which will bear smaller sized birds, provided that no other safety factors are endangered.

The sampling method foreseen for this category of birds is that described by Järvinen and Väisänen (1977), which consists of a line transect where populations located within the boundaries of the main belt (50 meters - 25 meters on each side of the observer) are differentiated from those of the survey belt. Main belt observations allow for the determination of comparable specific densities and seasonal fluctuations. The drawback to this method is that the sample is always quite small, especially with low density populations. Therefore, many species, of potential interest in terms of size, are often overlooked. Survey belt sampling, on the other hand, provides additional information, since the sample size is logically larger. Due to differences in interspecific and temporary detectability, the results are not strictly comparable between species and months, but they do give a general idea of numbers of scarce bird species.

Line transects have been drawn up for each vegetation unit in the airport zone, attempting to assure that each

line transect follows the runway pattern as closely as possible. The length of each line transect will vary according to the amplitude of the ecosystem in question. Sampling along these line transects allows for calculation of the following values and indices:

- Sample number: numbered successively from 1 to n (number of samples actually taken). Its sole purpose is to enable identification of each sample on the table.
- Line transect: This is identified by an alphanumeric code (for example, M1, M2, etc.) for each type of vegetation and airport.
- Sample date/s.
- Time observation begins and ends: in solar time.
- Specific density: expressed in number of contacts with a given species/10 hectares in the main belt and number of contacts/km. in the survey belt.
- Total contacts: total number of contacts per sample in the main belt and survey belt.
- Total density: total number of contacts/10 hectares per sample and total number of contacts/km. inventoried.
- Diversity: this parameter provides a good estimate of the population "maturity" and is calculated using the data obtained in the main belt as per the following equation:

  $$H' = -\sum P_i \lg_2 P_i$$

  where P_i is the frequency of species i. This parameter depends directly on two components; the number of species present and their relative proportions. Maximum values are obtained for a given number of species when all are present in the same proportions. In bird communities, this value varies from 0 (none) to 4.
- Total biomass: this is the sum of specific biomasses multiplied by their densities within the main belt and is expressed in gr./hectare.
- Remarks: Miscellaneous data which could affect sampling results, such as climatology, passage of different species, etc.

To illustrate this methodology, three different informative tools are included: (i) the map of vegetation in and around the Palma de Mallorca airport with line transects (M1, M2, etc. - see fig. 2), (ii) a table summarizing the results obtained in the main belt for the month of February, and (iii) a graph of the evolution of biomass/10 hectares during the first months of the sampling campaign.

4. BIRD FLOWS

This heading encompasses all birds flying over the airport on a daily basis. At higher frequencies and lower flying heights, these flows constitute a potential risk factor.

Bird flows are estimated via direct observations from fixed points (code A1, A2, etc. - see fig. 2) for a period of 20 minutes. The total number of 20 minute observations will vary according to the specific point and its importance vis-a-vis the airport in terms of the number of birds overflying it. During this observation period, all birds larger or equal to a blackbird are recorded, provided that the flow is large enough (flocks of more than 3 individuals or continuous passage). Large species are always recorded. Data gathered on each flock includes the following:

- Observation point,
- Time observation begins and time when the flock is actually observed (solar time),
- Number of individuals of each species,
- Direction of entry and exit, broken down into 8 classes: N, NE, E, SE, S, SW, W and NW,
- Approximate flying height,
- Remarks: climatology, ethology, etc.

Table 2 demonstrates the results obtained during the month of February in the Santander Airport and figure 4 summarizes in graph form the major bird flows observed during that same period.

5. BIRDS LOCATED ON RUNWAYS AND SURROUNDING AREAS

In certain airports, this is perhaps the most problematic group, given its specific behaviour. This is due to three factors: first, the bird itself is generally equal to or larger in size than a Pluvialis apricaria (over 200 gr.), second, its behaviour vis-a-vis aircraft is dangerous, since it may take flight during airplane take-offs and landings, and finally, they normally locate themselves on the end of runways.

Sampling is carried out on two different days, with a minimum of three observations performed per day: one in the morning, one at mid-day and the other in the afternoon. The methodology consists of walking through the airport zone and recording the following information for each flock located within the area:

- Flock number,
- Observation time (solar time),
- Location according to a map drawn to 500 x 200 m. grid size,
- Area on the runway where the bird alights,
- Number of individuals and species in the flock.

To illustrate this category, a listing of birds identified at the Menorca Airport (table 3) has been included, along with a graph mapping their distribution (figure 5).

6. ROOSTING PLACES

Although the size of birds roosting within the airports surveyed is not excessive (most were starlings, approximately 80 gr.), when these birds form large flocks (several thousand) they can become a nuisance if they must cross runways to enter their roosting place.

All roosting areas are inventoried in their entirety once a month. The information recorded on each area is reflected in a table containing the following points:

- Date,
- Observation time (solar time),
- Species and number of individuals present,
- Direction of entry or exit, broken down into 8 classes: N, NE, E, SE, S, SW, W, and NW,
- Remarks: climatology, ethology, etc.

Table 4 shows the information collected on starling roosting grounds within the Barcelona Airport.

7. OUTSIDE AREAS

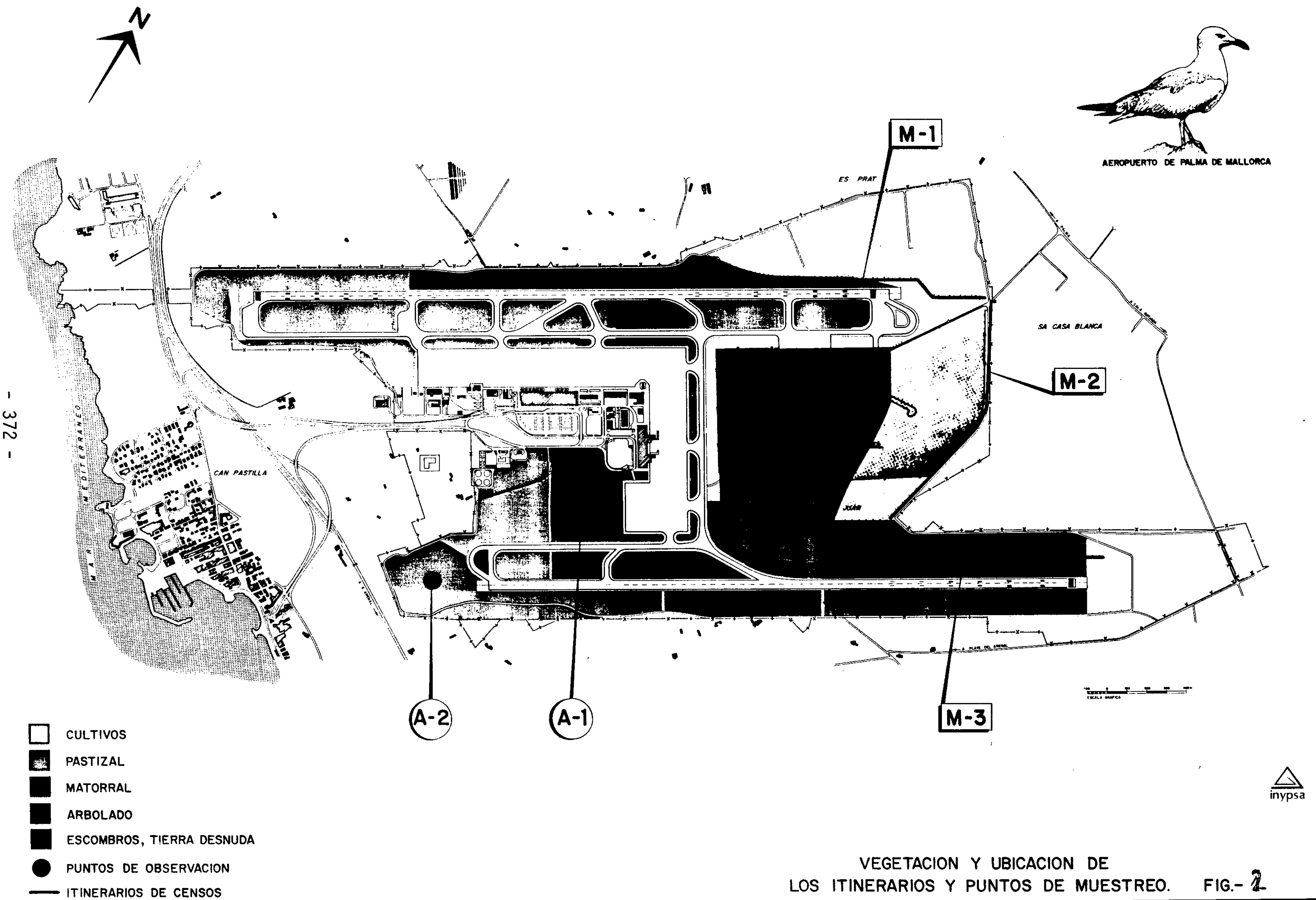
It is useful to study these areas since the direction of many bird flows can be conditioned by the presence or absence of a certain focus of attraction such as, rubbish dumps, dams, etc. A monthly inventory of the following information is compiled:

- Observation date,
- Observation time (solar time),
- Estimated coverage of the sample,
- Species and numbers observed.

Figure 6 lists a number of external sites around the Tenerife-Sur Airport. These include a dam (E1), a landfill (E2) and fish drying beds (E3). The presence of these zones can help to explain the bulk of all Herring and Lesser black-backed gull (*Larus argentatus* and *L. fuscus*) flows around this airport.

8. ADDITIONAL INFORMATION

Apart from these systematic observations, a series of additional elements are studied, i.e., the airport management plans, the identification of dead birds found around or on the airport grounds, records and sightings of collisions, etc. This information is of vital interest for the comparison and interpretation of data collected for the purpose of this survey.



VEGETACION Y UBICACION DE LOS ITINERARIOS Y PUNTOS DE MUESTREO. FIG.- 2

AEROPUERTO DE PALMA DE MALLORCA

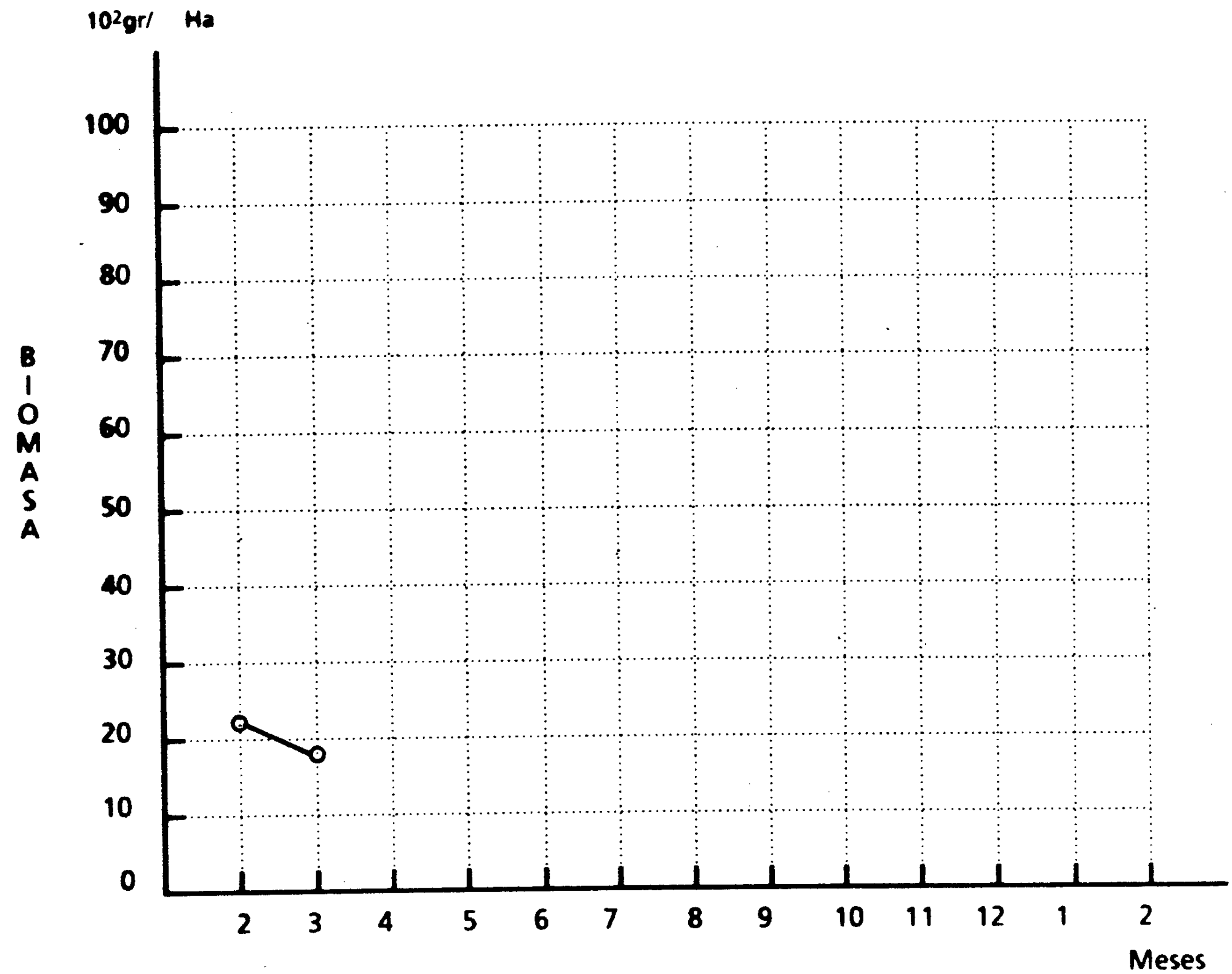
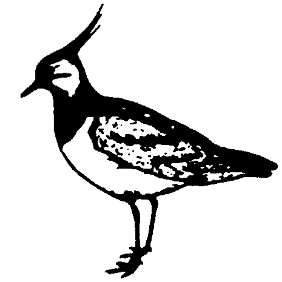
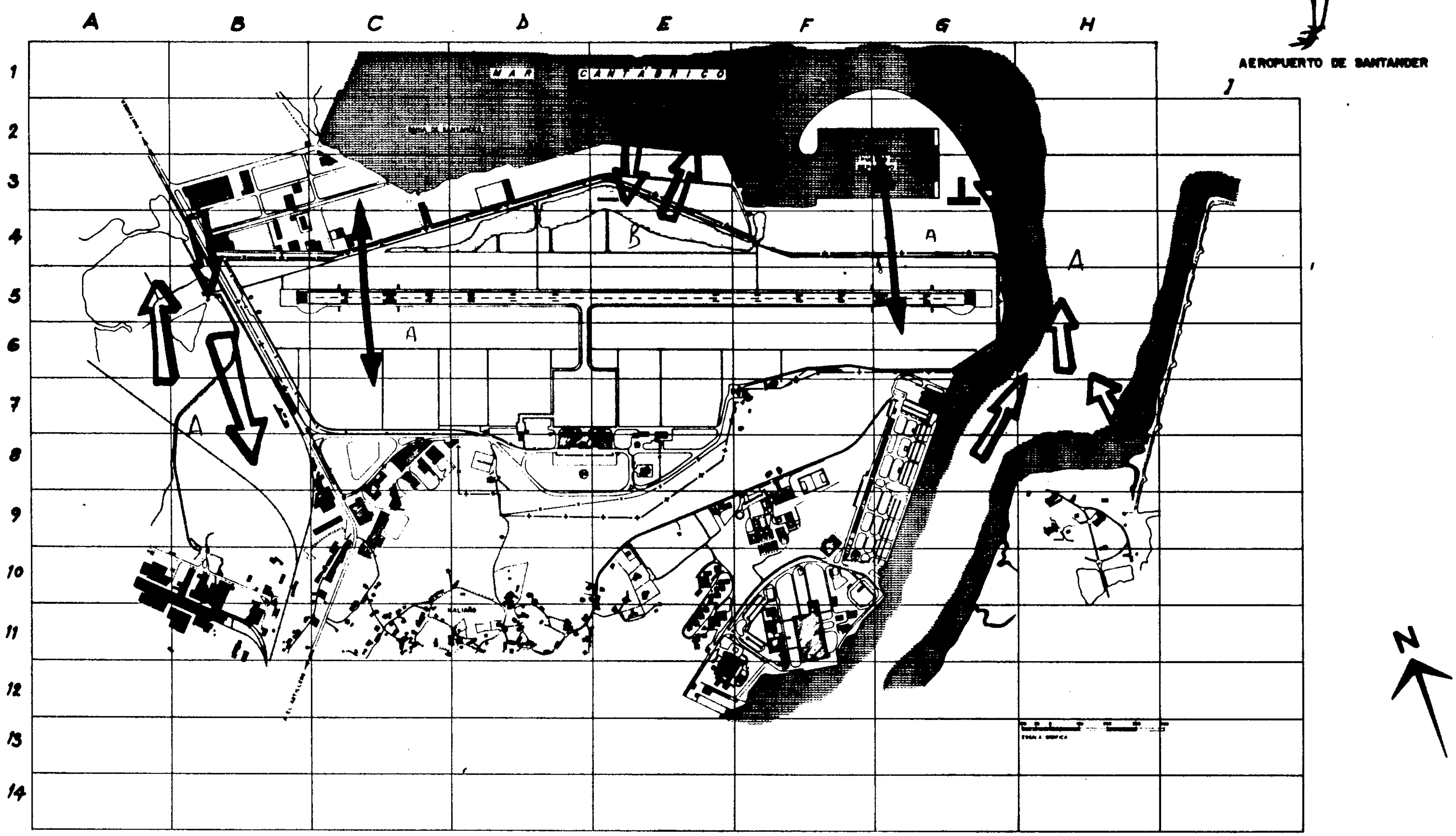


Fig. 3

MES : FEBRERO

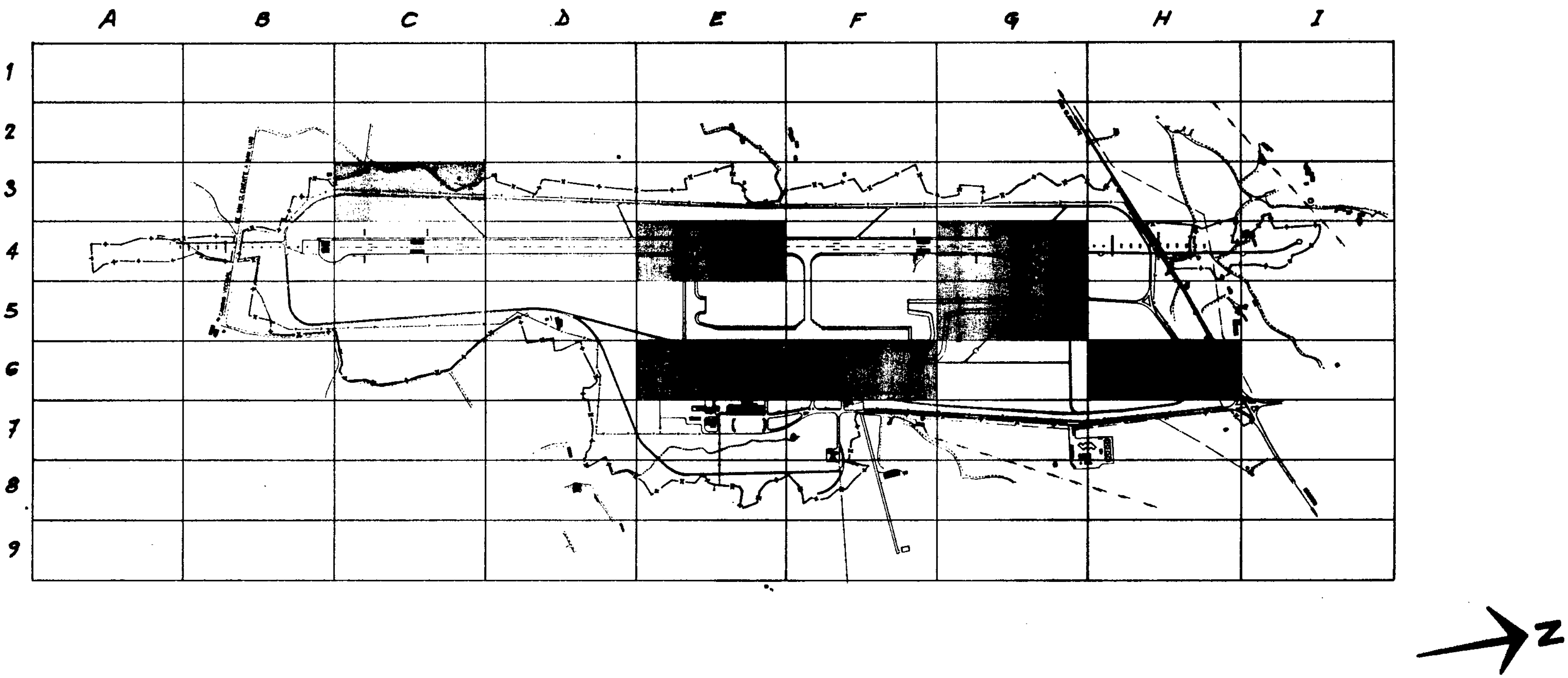
FIG. 4 FLUJOS PREFERENTES





MES : FEBRERO

FIG. 5 LOCALIZACION DE BANDOS POSADOS



inypsa

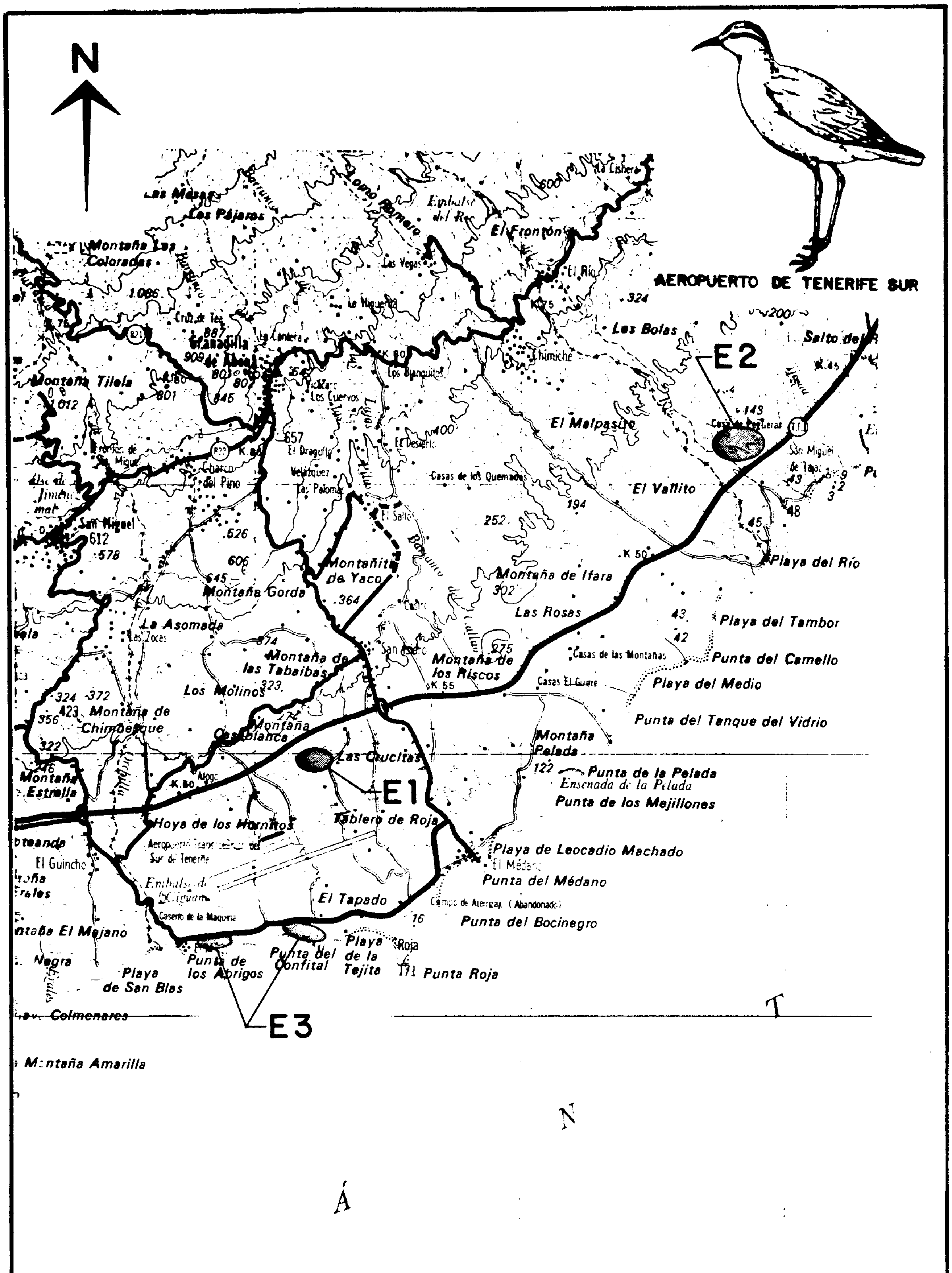


FIG. 6 LOCALIZACION DE LAS AREAS EXTERNAS

TABLE 1

AEROPUERTO DE:PALMA DE MALLORCA   FECHA(Año,mes):8602
DATOS DENTRO DE BANDA.RESULTADO DE LOS TAXIADOS(Contactos/10Ha.)

		01	02	03	04	05	06
NUMERO DEL MUESTREO.		01	02	03	04	05	06
CODIGO DEL ITINERARIO		M1	M2	M3	M1	M2	M3
FECHA (Ano,mes,dia)		860208	860208	860208	860211	860211	860211
HORA COMIENZO MUESTREO(GMT)		0727	0800	0903	0740	0815	0851
HORA FINAL MUESTREO(GMT). . .		0800	0845	0940	0815	0844	0917
COD.	**ESPECIE**	**01**	**02**	**03**	**04**	**05**	**06**
110	CERNICALO VULGAR	—	—	—	—	—	—
114	PERDIZ ROJA	—	—	—	—	—	2.00
136	AVEFRIA	—	—	2.00	—	2.80	—
138	CHORLITO DORADO COMUN	—	—	—	—	—	—
150	ARCHIBEBE COMUN	—	—	—	—	—	—
159	AGACHADIZA COMUN	—	—	28.00	—	—	8.00
175	ALCARAVAN	—	—	36.00	44.44	—	188.00
185	GAVIOTA ARGENTEA	—	—	—	—	—	—
243	ABUBILLA	1.34	1.40	—	1.34	2.80	—
257	ALONDRA COMUN	22.89	14.04	32.00	39.05	—	52.00
271	MOSQUITERO COMUN	—	—	—	2.69	—	—
275	BUITRON	8.08	5.61	—	8.08	2.80	6.00
280	CURRUCA CABECINEGRA	2.69	9.83	10.00	—	4.21	8.00
301	PETIRROJO	—	—	—	—	1.40	2.00
303	COLIRROJO TIZON	—	1.40	—	—	—	—
305	TARABILLA COMUN	14.81	16.85	2.00	17.50	15.44	14.00
315	ZORZAL COMUN	—	35.11	24.00	1.34	25.28	16.00
318	MIRLO COMUN	—	—	—	—	1.40	2.00
323	BISBITA COMUN	9.42	25.28	2.00	4.04	1.40	—
330	LAVANDERA BLANCA	—	—	—	—	1.40	2.00
350	TRIGUERO	6.73	11.23	—	4.04	—	—
361	JILGUERO	—	—	—	—	—	—
363	PARDILLO COMUN	6.73	—	12.00	4.04	5.61	2.00
367	VERDECILLO	—	—	—	—	—	—
375	GORRION COMUN	1.34	15.44	—	—	28.08	—
998	COLUMBA Sp.	—	—	—	—	—	—
TOTAL CONTACTOS D.B		55.00	97.00	74.00	94.00	66.00	151.00
DENSIDAD TOTAL(Contactos/10Ha)		74.07	136.23	148.00	126.59	92.69	302.00
DIVERSIDAD		2.72	2.91	2.66	2.43	2.73	1.92
BIOMASA TOTAL (Gramos/Ha.)		188.48	493.23	2160.7	2118.5	402.03	8523.7

OBSERVACIONES
MUESTREO 1 :BUENA TEMPERATURA.NUBES Y CLAROS.VIENTO LIGERO
MUESTREO 2 :BUENA TEMPERATURA.NUBES Y CLAROS.VIENTO LIGERO.LLOVIZNA.
MUESTREO 3 :BUENA TEMPERATURA.NUBES Y CLAROS.SIN VIENTO
MUESTREO 4 :DESPEJADO.SOLEADO.SIN VIENTO.HELADA NOCTURNA
MUESTREO 5 :DESPEJADO.SOLEADO.SIN VIENTO.HELADA NOCTURNA
MUESTREO 6 :DESPEJADO.SOLEADO.SIN VIENTO.HELADA NOCTURNA

Tabla 1
Resultados de los itinerarios en la banda principal.

TABLA 2

OBSERVACIONES DEL FLUJO DE AVES

PUNTO	FECHA	HORAS (Solares) Comienzo	Observación	Nº BANDO	ESPECIE	Nº INDIVIDUOS	DIRECCION Entrada	Salida	OBSERVACIONES	ALTURA
A_1	4-2-86	11.50	11.51	1	Gaviota argéntea	3	S	N	Ciclean	
A_1	4-2-86	"	12.03	2	Avefría	95	-	W	Salen a prados del W	
A_1	6-2-86	11.03	11.05	3	Gaviota reidora	15	N	S	-	
A_1	"	"	11.08	4	Gaviota argéntea	3	N	S	-	
A_1	"	"	11.11	5	Gaviota reidora	22	NW	NW	Ciclean y se reciclan por el mismo lugar	
A_1	"	"	11.13	6	"	45	NE	S	Ciclean sobre carretera	
A_1	"	"	11.19	7	"	7	N	S	-	
A_3	"	9.50	9.55	8	Cormorán grande	2	NW	N	Entran y salen al poco rato sin posarse en laguna	
A_1	7-2-86	12.50	13.03	9	Gaviota argéntea/ sombría	4	S	NE	-	
A_1	"	"	13.02	10	Paloma bravía	4	S	N	-	
A_2	"	11.06	11.06	11	Gaviota argéntea/ sombría	3	N	S	-	
A_2	"	"	11.11	12	Gaviota argéntea	9	SW	NE	Pasan bordeando por la ría	
A_2	"	"	11.13	13	Gaviota argéntea/ sombría	14	SE	N	Giran y ciclean	
A_2	"	"	11.14	14	"	11	S	N	Ciclean sobre la cabecera	
A_2	"	"	11.14	15	Gaviota argéntea	4	S	N	Giran	
A_2	"	"	11.15	16	Gaviota argéntea/ sombría	8	SW	N	Cicleos continuos	

TABLA 3

OBSERVACIONES DE AVES POSADAS EN PISTA Y AREAS CIRCUNDANTES

BANDO	FECHA	Horas de Observación (solar)	RETICULA	ZONA DE LA PISTA	ESPECIE	INDIVIDUOS
B_1	29-01-86	6.00	E6		Gaviota argéntea	3
B_2	29-01-86	6.00	E6-F6	Parking de aviones	Gaviota argéntea	2
B_3	29-01-86	6.00	G5	Rodadura norte	" "	2
B_4	29-01-86	8.00	E6-F6	Parking de aviones	" "	2
B_5	29-01-86	8.00	G5	Rodadura norte	" "	3
B_6	29-01-86	8.00	C3	Explanada ILS	" "	2
B_7	29-01-86	8.00	H6	-	" "	11
B_8	29-01-86	8.00	G4	Pista de despegue cabecera	" "	2
B_9	29-01-86	10.00	G4	Pista de despegue cabecera	" "	1
B_{10}	29-01-86	10.00	E6	Parking de avionetas	" "	1
B_{11}	29-01-86	12.00	H6	-	" "	14
B_{12}	29-01-86	12.00	G4	Pista de despegue cabecera	Chorlito dorado	1
B_{12}	29-01-86	14.30	E6-F6	Parking de aviones	Gaviota argéntea	1
B_{13}	29-01-86	14.30	C3	Explanada ILS	" "	2
B_{14}	30-01-86	6.00	E6-F6	Parking de aviones	" "	2
B_{15}	30-01-86	8.30	E6-F6	Parking de aviones	" "	2
B_{16}	30-01-86	8.30	E6	Parking avionetas	" "	1
B_{17}	30-01-86	10.30	C3	Explanada ILS	" "	3
B_{18}	30-01-86	13.30	E6-F6	Parking aviones	" "	2
B_{19}	31-01-86	9.30	G5	Rodadura norte	" "	1
B_{20}	31-01-86	9.30	C3	Explanada ILS	" "	2
B_{21}	31-01-86	13.00	C3	Explanada ILS	" "	1
B_{22}	01-02-86	8.30	G5	Rodadura norte	" "	1
B_{23}	01-02-86	8.30	E4	Pista de despegue tramo medio	" "	4
B_{24}	01-02-86	12.00	E6-F6	Parking aviones	" "	1
B_{25}	01-02-86	12.00	E6	Parking avionetas	" "	2

TABLA 4 : DORMIDEROS

PUNTO	FECHA	HORARIO OBSERVACION (SOLAR)
D-1	30/2/86	15,30 - 17,10

Hora de observación	Especie	Nº individuos	Dirección entrada
16,18	Estornino pinto	7	SW
16,19	"	2	NW
16,19	"	8	NE
16,20	"	3	NE
16,21	"	10	NE
16,21	"	60	W
16,22	"	53	W
16,24	"	1	W
16,25	"	20	W
16,25	"	10	NW
16,25	"	11	W
16,25	"	2	NW
16,31	"	260	W
16,32	"	1	W
16,34	"	2000	W
16,34	"	500	W
16,35	"	120	W
16,36	"	5	E
16,38	"	25	W
16,38	"	15	W
16,42	"	1	W
16,43	"	10	W
16,44	"	10	W
16,48	"	40	SE
16,51	"	15	SE
16,53	"	11	W
16,53	Lavandera blanca	25	NE
16,55	Estornino pinto	6	S

TABLE 4

PUNTO	FECHA	HORARIO OBSERVACION (SOLAR)
D-1	30/2/86	15,30 - 17,10

Hora de observación	Especie	Nº individuos	Dirección entrada
16.55	Estornino pinto	10	W
16,57	"	60	SW
16,57	"	30	NE

ADF616078

KLM KONINKLIJKE LUCHTVAART MAATSCHAPPIJ N.V.	Datum March 24,'86

Van Dienst/Bur./Afd. FLIGHT SUPPORT SERVICES DEPT. RAPPORT Nr.: 008BA

Onderwerp : Birdstrikes during 1985

Samensteller : C. Bakker

Aan : AMS/OL
Mr. C.H. Schoen

Cc : AMS/AD, AMS/OA, AMS/OD, AMS/OV, AMS/NP, AMS/NE, AMS/DV, SPL/TA, SPL/CE, SPL/CA, SPL/BE, NVLS, RLD/LT

1. General

Total number of detected birdstrikes 1985	74	(100%)
Birdstrikes at Amsterdam Schiphol	20	(27%)
at Aerodromes inside Europe	19	(25.7%)
at Aerodromes outside Europe	32	(43.2%)
en route	3	(4.1%)

2. Lists of birdstrikes at airports during 1985 (see attachments)

T = Take-off

C = Climb

A = Approach

L = Landing

3. Number of birdstrikes for KLM per airport 1985

		Nr. of strikes	Movements *	Strike/10.000 mov. 1985	1984	1983	1982	1981
Amsterdam	SPL	20	61.990	3.2	5.6	4.7	5.4	4.6
Rotterdam	RTM	2	3.942	5.1	2.3	2.1		
Lisbon	LIS	2	728	27.4	18.2	36		
London	LHR	3	7.852	3.8	1.4	2.6		
Milan	LIN	x	1.430	-	14.2	13.7		
Paris	CDG	x	3.650	-	8.1	2.2		
Vienna	VIE	1	1.344	7.4	15.1	4.5		
Zurich	ZRH	1	2.010	4.9	13.1	6		
Curacao	CUR	2	754	26.3				
Arusha	JRO	10	210					
KLM World-wide		74	168.863	4.4	5.67	4.14	5.4	6.2

* A movement is a landing or a take-off.

4. References

1. Pilots birdstrike report
2. Monthly birdstrike survey of Central Engineering Department
3. Actual Program of Logistics Department
4. KLM Insurance Department

   Damage costs without consequential losses approxemately
   $ 7.058.350,-

1985

KLM		AIRPORTS		PHASE OF FLIGHTS											REGISTRATION, IDENTIFICATION AND COSTS.
DATE	AMS	Inside Europe	Outside Europe	T	C	A	L	F-27	F-28	DC-9	DC-8-63	A310	DC-10	B-747	
JAN															
18			SIN	X										X	PH-BUB
18			JNB	X										X	PH-BUG
FEB															
9	X			X										X	PH-BUN
MAR															
13		IST					X				X				PH-AGH
15	X					X		X							PH-KFI
20			ATL				X							X	PH-BUD
30	X				X					X					PH-DNC
															Sea-gull
31			CUR	X									X		PH-DTD
															Cattle egret
31	X			X						X					PH-DNM
															Seagull
APR															
3		STR					X	X							PH-CHD
															Lapwing
4			JRO			X						X			PH-AG
4			JRO	X								X			PH-AG
7			CUR			X							X		PN-DTA
															Falcon
8			JRO	X								X			PH-AGI
															$1.350
14	X			X										X	N1309E
15			JRO	X								X			PH-AGH
28		GOT				X				X					PH-DNR
29			JRO				X					X			PH-AGI
29			JRO	X								X			PH-AGI
MAY															
.8	X					X				X					PH-DNW
27		HAM				X				X					PH-DNR
															Swift

KLM		AIRPORTS		PHASE OF FLIGHTS											REGISTRATION, IDENTIFICATION AND COSTS.
DATE	AMS	Inside Europe	Outside Europe	T	C	A	L	F-27	F-28	DC-9	DC-8-63	A310	DC-10	B-747	
JUN															
11		ZRH			X					X					PH-DNL
															Swallow
14		RTM		X					X						PH-CHF
17			JRO			X						X			PH-AGH
17			JRO				X					X			PH-AGH
17			JRO	X								X			PH-AGH
22	X			X						X					PH-DNI
27			DEL			X								X	PH-BUD
															$ 2,4 milj.
JUL															
4	X					X						X			PH-AGE
															Sparrow
5			DEL				X							X	PH-BUC
8		BHX		X					X						PH-CHD
14			DEL	X										X	PH-BUD
28	X			X										X	N 4548 M
															Wood pigeons
23		LHR				X						X			PH-AGA
															Sparrow
AUG															
5	En-route				X					X					PH-DOB
7			VCP		X								X		PH-DTA
9	X						X			X					PH-DNI
11	X			X									X		PH-DTC
															Seagull
12		LIS		X									X		PH-DTA
19		RTM		X				X							PH-CHF
23	X			X						X					PH-DNO
															Falcon
27	X			X										X	PH-BUE
															Doves
															$ 80.000,-
27			SIN			X								X	PH-BUL
30			AUA				X						X		PH-DTL
31		VIE		X						X					PH-DNL

KLM DATE	AIRPORTS AMS	Inside Europe	Outside Europe	PHASE OF FLIGHTS T	C	A	L	F-27	F-28	DC-9	DC-8-63	A310	DC-10	B-747	REGISTRATION, IDENTIFICATION AND COSTS.
SEP															
4			GIG	X									X		PH-DTB Cattle egrets $4.5 milj.
4			CGK		X									X	PH-BUD
12			KRT			X						X			PH-AGF
14			NRT	X										X	N1295E
15	X			X						X					PH-DOA Seagull $ 10.000
19		LHR				X				X					PH-MAX Pigeon
19		NCL		X						X					PH-DNY Crow
21			KAN	X									X		PH-DTC
21		HAN					X			X					PH-DNC
26			LAX	X										X	PH-BUD $ 5.000,-
OCT															
1	X			X										X	PH-BUK
4			LOS				X						X		PH-DTA
10	En route											X			PH-AGI
23	X						X			X					PH-DNM Falcon
29		EIN				X		X							PH-KFG
NOV															
4			LOS	X									X		PH-DTA
6			GIG			X							X		PH-DTB
9			LAX	X										X	PH-BUO
12	X						X					X			PH-AGF
13	En route							X							PH-CHB
18		LIS		X							X				PH-MAX
18	X					X			X						PH-CHF Lapwings
18	En route				X				X						PH-CHF Seagull $ 10.000,-

KLM		AIRPORTS		PHASE OF FLIGHTS											REGISTRATION, IDENTIFICATION AND COSTS.
DATE	AMS	Inside Europe	Outside Europe	T	C	A	L	F-27	F-28	DC-9	DC-8-63	A310	DC-10	B-747	
DEC															
1	X						X			X					PH-DNP
5		MUC		X						X					PH-MAX Seagull ($1000.-)
9		LHR				X						X			PH-AGK Seagulls
25			MVD	X									X		PH-DTC Cattle egrets $ 2000
27	X						X			X					PH-DNR Lapwings
29			JRO	X								X			PH-AGH Swallow

ADF616079

BIRD STRIKE COMMITTEE EUROPE

Copenhagen, May 1986
BSCE/18 WP 35
(Provided subsequent
to Meeting)

BIRD STRIKES DURING 1984 TO EUROPEAN REGISTERED CIVIL AIRCRAFT

(Aircraft over 5700 kg Maximum Weight)

J Thorpe - UK
R van Wessum - Netherlands

SUMMARY

The strikes reported throughout the World in 1984 by operators from fourteen European countries have been analysed. The analysis includes rates for countries, aircraft types and aerodromes based on aircraft movements. It also covers bird species, part of aircraft struck, effect of strike, and airlines affected.

The strike rate in 1984 was at 5.0 per 10,000 movements, slightly lower than the two previous years. Gulls (Larus spp.) were involved in 41% of the incidents. The major effect was damage to 127 engines.

CONTENTS

This study is based on information supplied and the accuracy and detail are only as good as that reported. Any opinions expressed are those of the author.

1 INTRODUCTION

1.1 In order that a common basis for the analysis of bird strike data could be agreed, a Working Group of the Bird Strike Committee Europe was formed in 1972, led by the representative from the United Kingdom Civil Aviation Authority Airworthiness Division at Redhill. Reports covering the individual years 1972 to 1983 inclusive have been presented to BSCE meetings. This paper contains the 1984 analysis.

1.2 Appendix 1 contains the Tables of data relating to this paper.

2 SCOPE

For the following reasons, the analysis includes all civil aircraft of over 5700 kg (12 500 lb) maximum weight, and executive jets which weigh just less than 5700 kg, eg Lear and Citation.

(a) the airworthiness requirements relating to bird strikes are different for the smaller class of aeroplanes,

(b) much more is known about the reporting standards of operators of transport types, and their movement data is more readily available than that for air taxi or private owner aircraft.

(c) aircraft of less than 5700 kg are in general, much slower with a different mode of operation, requiring less airspace, and a noticeably different strike rate would be expected.

3 DISCUSSION

3.1 Annual Rate/Country (See Table 1)

(a) Information has been obtained from a total of fourteen European countries. A few of these were not able to provide full information, and their data therefore, appears in some tables and not in others.

(b) The overall strike rate for the 1404 incidents contained in this analysis is 5.0 per 10,000 movements (two movements per flight). This is less than the rate of 5.6 recorded during 1983 (4.6 in 1982). Two of the most efficient reporting countries (Germany and Switzerland) are only partially included; this may have resulted in the apparent lowering of the rate.

(c) The strike rate reported by each country is dependent upon two major factors -

- reporting standard

- the bird strike problem at airports within that country, and that country's airlines route structure.

(d) The country with the highest reported strike rate and possibly the most efficient reporting is Italy with 14.1 per 10,000 movements, followed by Ireland with 7.2.

3.2 **Aircraft Types** (See Table 2)

(a) Jet Aeroplanes

(i) For several years there appears to have been no consistent correlation between aircraft of similar design, eg DC8 and B707, DC10 and L1011. It may be that aircraft which appear similar to humans are not similar to birds, and there are other factors such as noise patterns, which can affect the strike rate. There is some difference in the strike rate of 4, 3 and 2 engined jets.

(ii) The DC8, DC10, A300,A310 and Mercure have above average strike rates.

(iii) The aircraft with the greatest damage rate are Concorde, DC10, Mercure, A300, A310 and TU134.

(iv) 25% of strikes to four engined jet powered aircraft cause damage while for three and two engined aircraft only 7% result in damage.

(b) Turboprop Aeroplanes

The average strike rate for all Turboprops is 3.6 compared with 5.7 for jets. The damage rate is the same as for jets.

(c) Helicopters

The number of strikes reported to helicopters is very low, only 14. Because helicopters fly mainly at low altitude where birds are most frequently found, they are continuously exposed to the risk of a strike. Therefore flying hours have been used to determine a strike rate. For reasons which are not at present known, the rate is low at 1.1 per 10,000 hours, the same as in 1983. There was only one case of damage to a helicopter.

3.3 **Aerodromes** (See Table 3)

(a) The aerodrome data is of particular importance as it may indicate where bird control measures need to be taken. Some countries were able to provide aerodrome movement data for their nationally registered aircraft, so that a national rate could be quoted.

The total number of strikes at each aerodrome, reported by all European sources has also been included.

(b) Strikes reported on aerodromes are influenced by one or more of the following:

   (i) reporting standards

   (ii) the prevailing bird situation which may vary according to place and time

   (iii) the number of aircraft movements

   (iv) the effectiveness of bird control measures

   (v) local factors, perhaps beyond control of the aerodrome, eg a rubbish dump or bird roost site in the vicinity.

(c) Because of factors outlined in (b), direct comparison of the reported strike rates for different aerodromes is likely to be misleading.

(d) European aerodromes with five or more damaging strikes are Paris CDG,Paris-Orly,Toulouse and Amsterdam.This may in some cases be a reflection of the aerodrome movements, local bird populations and reporting efficiency.

(e) Significant numbers of strikes have been reported at aerodromes outside Europe. Eleven strikes were reported at Bangkok and Delhi. Three of the incidents at Nairobi resulted in damage.

3.4 **Bird Species** (See Table 4)

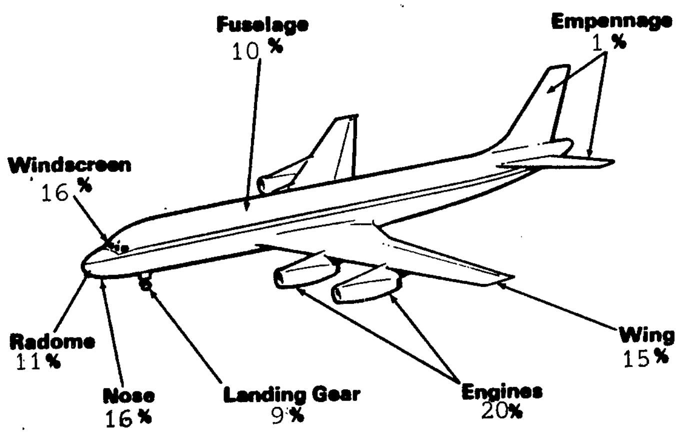
Some knowledge of the bird species involved was available in 56% of incidents. The identification standard ranged from examination of bird remains by a trained ornithologist to the fleeting glance of a pilot. Overall 41% of strikes involved gulls (Larus spp.) of which the Black-headed gull (Larus ridibundus) was the most frequently identified. This is similar to 1983. Next on the list was the Lapwing (Vanellus vanellus) with 17% and the combination of swift/swallow/martin at 11%. Birds of prey accounted for 7%. Eight incidents were believed to involve a bird heavier than 1.81 kg (4lb).

Gulls were involved in 60% of damaging incidents (but 41% of strikes) where the birds involved were known.

The birds struck during the last nine years are summarised overleaf. There does not appear to be a clear trend.

Birds	76	77	78	79	80	81	82	83	84
					YEAR				
Gulls (Larus spp.)	44	41	41	41	41	45	33	35	41
Lapwing (Vanellus vanellus)	14	10	11	10	12	9	14	13	17
Birds of Prey (Falconiformes)	8	9	8	8	10	12	9	8	7
Pigeons (Columba spp.)	7	9	7	7	7	7	7	8	6
Swift/swallow/martin	11	12	13.5	18	15	11	13	18	11

3.5 **Part of Aircraft Struck** (See Table 5)



From the figure the parts most frequently reported as being struck can be seen.

It should be noted that there were 29 incidents where more than one engine was struck, of which 20 affected all engines (the same figures as in 1983).

3.6 **Effects of Strikes** (See Table 6)

(a) During 1984 a total of 127 engines were damaged such as to require repair or replacement (seven more than in 1983). Of these 68 were on twin engined aircraft. It appears that 35% of reported engine strikes involved engine damage.

(b) Only six windscreens were changed, a small number compared with the 302 windscreen strikes. None of these was known to involve penetration.

(c) There were 8 cases of radome damage, out of 214 radome strikes. In most cases the radome was only delaminated, but in a few cases it was shattered. The radome strength is limited by the need for dielectric properties enabling satisfactory operation of the weather radar.

3.7 <u>Cost</u>

The number of countries able to provide cost information was too small to warrant analysis, although one country had experienced incidents which cost a total of 15 million U.S. dollars.

3.8 <u>Aircraft Operator Reporting</u> (See Table 7)

This table provides a guide to the reporting efficiency and problems of individual airlines. It is probable that it is considerably affected by the airport(s) at which the airline has its main base.

4 <u>CONCLUSIONS</u>

4.1 The overall rate for the 1404 strikes reported during this period by European operators is 5.0 strikes per 10,000 movements. Probably due to a change in the reporting countries,this rate is slightly lower than in previous years.

4.2 There does not appear, from the available data, to be any close correlation between the strike rate and the aeroplane type in terms of speed, engine type etc.

4.3 Some aircraft for reasons which are unknown, have a much higher strike rate, whilst others have a higher rate of damage.

4.4 The percentage of strikes which cause damage is three times greater on 4 engined jet powered aircraft than on 3 or 2 engined aircraft.

4.5 There are some airports outside Europe where the number of bird strikes reported by European operators is high even though movements by European registered aircraft at these airports are believed to be low. Damage occurred at several of these airports.

4.6 Gulls (Larus spp.) were struck more frequently than other birds, being involved in 41% of incidents where the bird species were known. Less than 1% of birds struck were believed to be greater than 1.8 kg (4 lb).

4.7 The nose section including the windscreen and radome were reported as being struck in 43% of incidents, with engines being struck in 20%. There were 29 incidents where more than one engine was struck.

4.8 The major consequences were damage to 127 engines. There were no aircraft written off, or occupants injured.

APPENDIX 1

BIRD STRIKE ANALYSIS

EUROPEAN OPERATORS 1984

CIVIL AIRCRAFT OVER 5700 KG (12.500 lb) MAXIMUM WEIGHT

Notes:

0.1 The following are excluded from this Analysis:

(a) aircraft of maximum weight 5700 kg (12.500 lb) and under, except for those few executive jets, which have been included, eg Lear and Citation.

(b) all military type and operated aircraft.

0.2 All Tables are for strikes reported world-wide.

0.3 The Total columns of many of the Tables are different, as some countries have not been able to provide full information for every table.

0.4 There are two movements per flight.

0.5 Where the number of incidents, or number of movements are small, and particularly where they are both small, the derived rate should be treated with caution.

Table 1 National Reporting - 1984

(A high rate may be due to efficient reporting)

Reporting Nation	Number of Incidents World Wide	Damaging Incidents	Number of Movements World Wide	Rates per 10,000 Movements Damage	All
Austria	20 (2)	2	54,380 *	0.4	3.7
Belgium	15	-	104,144	-	1.4
Czechoslovakia	26	4	48,584 *	0.8	5.3
Denmark	40	N/A	193,914	0.2	2.1
Finland	56	4	137,712	0.3	4.1
France	279 (29)	55 (12)	548,747	1.0	5.1
Germany	N/A	N/A (80)	N/A	N/A	N/A
Ireland	49 (1)	N/A	67,636 *	-	7.2
Italy	224	10	158,636 *	0.6	14.1
Netherlands	97 (6)	19 (1)	188,566	1.0	5.1
Norway	N/A (67)	N/A	N/A	N/A	N/A
Sweden	75	4	245,357	0.2	3.1
Switzerland	N/A(150)	N/A (5)	N/A	N/A	N/A
United Kingdom	523 (32)	39	1,084,548	0.4	4.8
Total	1404(287)	137 (98)	2,832,224	0.5	5.0

Notes:

1.1 There are two movements per flight.

1.2 * Movement data from ICAO sources.

1.3 Helicopters are excluded from this Table.

1.3 The figures in brackets are strikes for which no movement data is available.

1.5 Damage rate excludes those countries who did not supply damage

(A high rate may be due to efficient reporting)

Table 2 AIRCRAFT TYPE - 1984

(A high rate may be due to efficient reporting)

Aircraft	Number of Countries Reporting	Number of Strikes Damage	Number of Strikes All	Number of Movements	Strike Rate per 10,000 Movements Damage	Strike Rate per 10,000 Movements All
JET						
McDonnel Douglas DC-8	7	(1) 3	(6) 42	18,123	1.7	23.2
BAe 146	1	1	7	10,350	-	6.8
Boeing 747	10	(10) 34	(8) 103	151,385	2.2	6.8
Illyushin 62	1	1	6	8,950	-	6.7
Boeing 707/720	4	(2) 2	(2) 10	18,488	1.1	5.4
Concorde	2	2	2	5,942	3.4	3.4
All 4 Engined Jets	-	(13) 43 25%	(16) 170	213,238	2.0	8.0
McDonnell Douglas DC10	11	(5) 9	(49) 61	66,884	1.3	9.1
HS Trident	1	-	27	57,698	-	4.7
Lockheed 1011 Tristar	2	(5) 2	(5) 10	30,216	0.7	3.3
Boeing 727	6	(15) 2	(15) 36	162,270	0.1	2.2
Yak 40	1	-	-	9,166	-	-
All 3 Engined Jets	-	(20) 13 7%	(69) 184	326,234	0.4	5.6
A300 Airbus	5	(3) 23	(3) 232	154,196	1.5	15.0
DA01 Mercure	1	9	(5) 55	47,830	1.9	11.5
A310 Airbus	5	(5) 3	(19) 21	23,728	1.3	8.9
Boeing 767	1	-	3	4,762	-	6.3
Boeing 757	1	2	26	48,048	0.4	5.4
Boeing 737	8	(29) 13	(42) 215	417,791	0.3	5.1
Tupolev 134	1	3	13	25,472	1.2	5.1
McDonnel Douglas DC-9	9	(4) 11	(117) 268	531,608	0.2	5.0
SE 210/212 Caravelle	3	4	27	60,176	0.6	4.0
BAC 1-11	2	1	80	206,970	-	3.9
Fokker F28	4	2	40	218,351	0.1	1.8
HS125	2	-	7	50,390	-	1.4
Cessna 500/550 Citation	2	-	1	3,838	-	-
DA20 Falcon	5	(3) 1	(3) 1	2,128	-	-
Learjet	4	-	(1) 1	5,644	-	-
SN 601 Corvette	2	(1) -	(2) -	2,488	-	-
All 2 Engined Jets	-	(45) 72 7%	(192) 980	1,811,670	0.4	5.4
ALL JETS	-	(78) 128 10%	(277) 1334	2,351,142	0.5	5.7
TURBOPROP						
Illyushin 18	1	-	7	4,996	-	14.0
BAC Viscount	1	1	(3) 23	32,546	-	7.0
DHC 7	4	-	7	34,874	-	2.0
Short Belfast	1	-	-	964	-	-
BAC Merchantman	1	-	1	4,604	-	-
HS Argosy	1	-	1	1,018	-	-
L188 Electra	1	-	(1) -	-	-	-
All 4 Engine Turboprops	6	1	(1) 39	79,002	-	4.9
HS 748	2	(3) 4	(3) 42	50,740	0.8	8.3
Short SD 330/360	3	2	48	118,350	0.2	4.1
Fokker F27/227	7	5	(1) 52	193,524	0.3	2.7
BAE Jetstream 31	2	(2) 0	(2) 5	19,830	-	2.5
HP Herald	1	1	4	28,174	-	1.4
Nord 262	2	(2) 0	(5) 0	8,974	-	-
C160 Transall	1	(1) -	(1) -	-	-	-
Gulfstream	1	-	(2) -	-	-	-
All 2 Engine Turboprops	-	(8) 12 8%	(18) 151	419,592	0.3	3.6
ALL TURBOPROPS	-	(8) 13 7%	(18) 193	498,594	0.3	3.9

PISTON						
Bristol 170 Freighter	1	-	-	194	-	-
Douglas DC3 Dakota	1	-	-	3,282	-	-
ALL PISTON	1	-	-	3,476	-	-
UNKNOWN	-	-	(34) -	-	-	-
TOTAL	-	(86) 141	(329) 1524	2,853,212	0.5	5.3

Aircraft	Number of Countries Reporting	Number of Strikes		Number of Hours	Strike Rate per 10,000 Hours	
		Damage	All		Damage	All
HELICOPTERS						
Bell 214	1	-	2	1,740	-	11.5
Sikorsky S61	3	-	(1) 7	60,056	-	1.2
AS332L	2	1	(1) 3	36,064	-	0.8
Boeing 234 Chinook	1	-	7	7,590	-	-
Westland WG 30	1	-	1	2,985	-	-
ALL HELICOPTERS	-	1	(2) 12	108,435	0.1	1.1

Notes: 2.1 Because of the low altitude of operation, and difficulty in collection of movement data, helicopter operations are quoted in hours.

2.2 The figures in brackets are for aircraft for which movement data is unavailable.

2.3 Where the number of incidents , or the number of movements is small and particularly where they are both small any derived rate should be treated with caution.

2.4 Damage data not supplied by Denmark, Ireland and Norway.

TABLE 3 AERODROMES - 1984

(A high rate may be due to efficient reporting)

Country/Aerodrome	Incidents	Movements	Rate per 10,000 Movements	Incidents to Other European Aircraft	Total Damage	Total All
AUSTRIA						
Innsbruck	1	-	-	-	-	1
Klagenfurt	2	-	-	-	-	2
Linz	2	-	-	1	-	3
Salzburg	1	-	-	2	-	3
Vienna	15 (1)	-	-	-	1	15
Graz	1 (1)	-	-	-	1	1
BELGIUM						
Brussels	4	-	-	4	-	8
Ostend	2	-	-	1 (1)	1	3
CZECHOSLOVAKIA						
Bratislava	3	-	-	-	-	3
Kosice	1	-	-	-	-	1
Prague	11 (2)	-	-	-	2	11
DENMARK						
Aalborg	1	-	-	4 (1)	1	5
Beldringe	1	-	-	-	-	1
Billund	2	-	-	-	-	2
Copenhagen	9	58,422	1.5	19 (2)	2	28
Esbjerg	5	-	-	-	-	5
Ronne	3	-	-	-	-	3
Thisted	-	-	-	1	-	1
FINLAND						
Helsinki - Vantaa	16	84,640	1.9	1	-	17
Jyvaskyla	4	23,304	1.7	-	-	4
Kajaani	4	3,840	10.4	-	-	4
Kemi	2	8,476	2.4	-	-	2
Kuopio	1 (1)	34,540	0.3	-	1	1
Mariehamn	7 (1)	7,120	9.8	-	1	7
Oulu	6	20,838	2.9	-	-	6
Pori	2	18,502	1.1	-	-	2
Savonlinna	1	3,742	2.7	-	-	1
Tampere	1	19,376	0.5	-	-	1
Turku	1 (1)	31,248	0.3	-	1	1
Vaasa	1	18,566	0.5	-	-	1
FRANCE						
Ajaccio	6	7,686	7.8	-	-	6
Basle-Mulhouse	2 (1)	7,543	2.6	-	1	2
Bastia	3	6,652	4.5	-	3	-
Bezier	-	-	-	2	-	2
Bordeaux	8 (1)	16,587	4.8	-	1	8
Brest	8 (2)	6,495	12.3	-	2	8
Calvi	3	2,284	13.1	-	-	3
Clermont Ferrand	2 (1)	7,518	2.6	-	1	2
Lille	5	8,856	5.6	-	-	5
Lourdes	7 (1)	1,365	51.3	-	1	7
Lyon - Satolas	8 (1)	38,105	2.1	-	1	8
Marseilles	15 (2)	36,330	4.1	1	1	16
Montpellier	5	9,676	5.1	-	-	5
Nice - Cote d'Azur	6	33,355	1.8	1	-	6
Paris - Charles de Gaulle	33 (8)	62,448	5.3	7 (2)	8	33
Paris - Le Bourget	3 (2)	6,962	4.3	-	2	3
Paris - Orly	48 (5)	117,548	4.1	-	5	48
Pau/Pont	3 (1)	5,697	5.3	-	1	3
Nimes - Garons	3	2,676	11.2	-	-	3
Perpignan	3	3,803	7.9	-	-	3
St Nazaire	3	1,189	25.2	-	-	3
Strasbourg	7 (1)	10,458	6.7	-	1	7
Toulouse - Blagnac	32 (6)	17,752	18.0	2	6	34
Vichy	2	283	70.6	-	-	2

GERMANY						
Berlin	-	-	-	2 (1)	1	2
Dusseldorf	2 (2)	-	-	3	2	5
Frankfurt	-	-	-	5 (1)	1	5
Geilenkirchen	1 (1)	-	-	-	1	1
Hamburg	4 (4)	-	-	-	4	4
Hannover	2 (2)	-	-	-	2	2
Munich	2 (2)	-	-	1	2	3
Munster	1 (1)	-	-	-	1	1
Stuttgart	1 (1)	-	-	1	1	2
GREECE						
Corfu	-	-	-	10 (1)	1	10
Samos	-	-	-	1	-	1
IRELAND						
Cork	7	-	-	-	-	7
Dublin	26	-	-	-	-	26
Shannon	3	-	-	-	-	3
ITALY						
Brindisi	-	-	-	2	-	2
Catania	7	4,093	17.1	-	-	7
Genoa	5 (1)	2,617	19.1	3	-	8
Milan - Linate	33 (1)	33,000	10.0	2	1	35
Milan - Malpensa	3	3,846	7.8	-	-	3
Palermo	3 (1)	8,333	3.6	-	1	3
Rimini	-	-	-	1	-	1
Rome - Fiumicino	38 (1)	52,778	7.2	3	1	41
Venice	21	7,292	28.8	2	-	23
Verona	-	-	-	1	-	1
NETHERLANDS						
Amsterdam	35 (11)	77,403	4.5	8 (1)	12	43
Rotterdam	1	4,334	2.3	-	-	1
NORWAY						
Bergen	9	35,523	2.5	4	-	13
Bodo	3	29,647	1.0	1	-	4
Flesland	-	-	-	3	-	3
Honingvag/Valan	1	4,766	2.0	-	-	1
Kristiansand	3	12,786	2.3	-	-	3
Oslo - Fornebu	16	70,690	2.3	10	-	26
Sola	-	-	-	1	-	1
Stavanger	7	38,102	1.8	-	-	7
Svolvaer/Helle	2	3,828	5.2	-	-	2
Tromso	1	20,545	0.5	-	-	1
POLAND						
Warsaw	-	-	-	1	-	1
PORTUGAL						
Faro	-	-	-	3	-	3
Lisbon	-	-	-	2	-	2
Porto	-	-	-	1	-	1
SPAIN						
Alicante	-	-	-	2	-	2
Gerona	-	-	-	1	-	1
Ibiza	-	-	-	8 (2)	2	8
Mahon - Menorca	-	-	-	4 (1)	1	4
Malaga	-	-	-	7	-	7
Palma de Mallorca	-	-	-	13 (2)	2	13
Reus	-	-	-	2	-	2
SWEDEN						
Angelholm	3	5,400	5.6	-	-	3
Gothenburg - Landvetter	-	-	-	1	-	1
Halmstad	3	3,490	8.6	-	-	3
Lulea	2	14,218	1.4	1	-	3
Malmo - Sturup	2	17,504	1.1	1	-	3
Stockholm - Arlanda	16	149,804	1.1	6	-	22
Umea	7	11,490	6.1	-	-	7
Vasteras Hasslo	3	1,880	16.0	2	-	5
Visby	5	10,224	4.9	-	-	5

SWITZERLAND						
Basle - Mulhouse	2	-	-	-	-	2
Geneva	20	-	-	2	-	22
Zurich	39 (2)	-	-	4 (1)	3	43
UNITED KINGDOM						
Aberdeen	10	73,094	1.4	-	-	10
Belfast Aldergrove	18	24,622	7.3	-	-	18
Belfast Harbour	6 (2)	8,446	7.1	-	2	6
Birmingham	22 (2)	26,150	8.4	3	2	25
Blackpool	3	13,636	2.2	-	-	3
Bournemouth - Hurn	9 (2)	11,592	7.8	-	2	9
Bristol - Filton	2	-	-	-	-	2
Bristol - Lulsgate	4	7,959	5.0	2	-	6
Cardiff - Wales	5	8,235	6.1	-	-	5
Coventry	2	1,652	12.1	-	-	2
Dundee	7	3,142	22.2	-	-	7
East Midlands	12	23,533	5.1	-	-	2
Edinburgh	15 (1)	25,684	5.8	2	1	17
Glasgow	24 (1)	42,648	5.6	2	1	26
Hatfield	3	-	-	-	-	3
Inverness	2	8,412	2.4	-	-	2
Kirkwall	3	8,142	3.7	-	-	3
Leeds - Bradford	4	10,010	4.0	1	-	5
Liverpool	6	16,566	3.6	-	-	6
London Gatwick	19 (1)	89,574	2.1	-	1	19
London Heathrow	22 (1)	138,260	1.6	14 (2)	3	36
London Stansted	11	14,821	7.4	-	-	11
Luton	14	23,867	5.9	-	-	14
Manchester	33	48,774	6.8	-	-	33
Newcastle	15	16,207	9.2	-	-	15
Norwich	6	8,711	6.9	-	-	6
Prestwick	1	3,731	2.7	-	-	1
Ronaldsway I of M	14	13,732	10.2	-	-	14
Southend	2	6,739	3.0	-	-	2
Stornoway	2	2,865	7.0	-	-	2
Sumburgh	1	11,666	0.9	-	-	1
Tees-side	11 (1)	9,156	12.0	-	-	11
Wick	2	3,394	5.9	-	-	2
USSR						
Leningrad	-	-	-	1	-	1

LIST OF AERODROMES WHERE MORE THAN ONE STRIKE, OR ONE STRIKE WITH DAMAGE HAS BEEN REPORTED BY EUROPEAN OPERATORS

Other Aerodromes

Delhi (India)	11 (2)	Douala (Cameroon)	2
Bangkok (Thailand)	11	Kano (Nigeria)	2
Banjul (Gambia)	10	Kinshasa (Zaire)	2
Jersey (Channel Islands)	9	Monrovia (Liberia)	2
Guernsey (Channel Islands)	8	Robertsville (Liberia)	2
Tunis (Tunisia)	7 (2)	Adelaide (Australia)	1 (1)
Nairobi (Kenya)	6 (3)	Baltimore (U.S.A.)	1 (1)
Burgas (Bulgaria)	3 (2)	Doha (Qatar)	1 (1)
Algier (Algeria)	3 (1)	Gander (Canada)	1 (1)
Colombo (Sri Lanka)	3	Harare (Zimbabwe)	1 (1)
Mombasa (Kenya)	3	Karachi (Pakistan)	1 (1)
New York JFK (U.S.A.)	2 (1)	Monastir (Tunisia)	1 (1)
Agadir (Morocco)	2		

En Route	51 (16)
Unknown	68 (10)

Notes: 3.1 Because of variability in reporting, bird population, aicraft movement pattern, control measures and features beyond control, any comparison between the rates calculated for different aerodromes is likely to be misleading.

3.2 The figures in brackets are incidents with damage. (Not supplied by Denmark, Ireland and Norway.

3.3 UK data on Strikes near Aerodromes (between 500 ft and 2,500 ft) have been excluded (21 incidents) as have carcasses found on aerdromes with impact damage.

TABLE 4 BIRD SPECIES - 1984

Scientific Name	English Name	Weight/Weight Category		Number of Incidents		% Based on 993
		Weight	Category	Damage	Total	
CICONIIFORMES						
Ardea sp	Heron	500 g - 4.5 kg	B	1	5	0.5
Ardea cinerea	Grey heron	up to 1.5 kg	B	-	2	-
Bubulcus ibis	Cattle egret	345 gr	B	-	1	-
Ciconia ciconia	White stork	2.4 kg	C	-	1	-
ANSERIFORMES						
Anas sp	Duck	250 g - 1.3 kg	B	1	5	0.5
Anas platyrhynchos	Mallard	1.1 kg	B	-	3	0.3
Anser sp	Goose	1.8 kg - 4.0 kg	C	3	3	0.3
Cygnus sp	Swan	4.7 kg - 12 kg	D	-	1	-
FALCONIFORMES						
Gyps sp	Vulture	up to 10 kg	C	1	1	-
Aquila sp	Eagle	1.1 kg - 4.2 kg	C	-	1	-
Aquila chrysaetos	Golden eagle	4.2 kg	D	-	1	-
Buteo sp	Buzzard	260 g - 1.3 kg	B	2	8	0.8
Buteo buteo	Common buzzard	800 g	B	1	6	0.6
Pernis apivorus	Honey buzzard	360 g - 1.5 kg	B	-	1	-
	"Hawk"	up to 1 kg	B	2	14	1.4
Accipiter nisus	Sparrow hawk	190 g	B	-	3	0.3
Accipiter gentilis	Goshawk	1.0 kg	B	-	1	-
Milvus sp	Kite	700 g - 1.0 kg	B	-	2	-
Milvus migrans	Black kite	780 g	B	2	8	0.8
Circus aeroginosus	Marsh harrier	320 g - 1.4 kg	B	-	3	0.3
Falco sp	Falcon	105 g - 1.3 kg	B	1	4	0.4
Falco tinnunculus	Kestrel	200 g	B	2	18	1.8
GALLIFORMES						
Tetrao tetrix	Black grouse	1.1 kg	B	-	2	-
Lyrurus tetrix	Common black grouse	810 g - 1.8 kg	B	1	3	0.3
Alectoris rufa	Red-legged partridge	450 g	B	-	1	-
Perdix perdix	Grey partridge	400 g	B	-	8	0.8
Phasianus colchicus	Pheasant	1.1 kg	B	-	2	-
CHARADRIIFORMES						
Haematopus ostralegus	Oystercatcher	500 g	B	-	5	0.5
Vanellus vanellus	Lapwing	215 g	B	12	166	16.7
Charadrius hioticula	Ringed plover	54 g	A	-	1	-
Pluricalis apricaria	Golden plover	185 g	B	-	1	-
Gallinago gallinago	Snipe	125 g	B	-	2	0.2
Gallinago megala	Forest snipe	150 g	B	-	1	-
Numenius arquata	Curlew	770 g	B	1	5	0.5
Philomachus pugnax	Ruff	140 g	B	1	2	-
Larus sp	Gull	280 g - 1.7 kg	B	39	299	30.1
Larus marinus	Great black backed gull	1.7 kg	B	-	4	0.4
Larus fuscus	Lesser black backed gull	820 g	B	-	3	0.3
Larus argentatus	Herring gull	1.0 kg	B	5	37	3.7
Larus canus	Common gull	420 g	B	1	18	1.8
Larus melancephalus	Mediterranean gull	280 g	B	-	1	-
Larus ridibundus	Black headed gull	275 g	B	1	41	4.1
Larus minutus	Little gull	80 g - 150 g	B	-	1	-
Sterna hirundo	Common tern	120 g	B	-	4	0.4
Chlidonias leucoptera	White winged black tern	40 g - 80 g	A	-	1	-
COLUMBIFORMES						
Columba sp	Pigeon	up to 465 g	B	4	37	3.7
Columbia oneas	Stock dove	345 g	B	-	2	0.2
Columba livia	Rock dove	395 g	B	1	8	0.8
Columba palumbus	Woodpigeon	465 g	B	3	15	1.5

STRIGIFORMES						
Strix sp	Owl	160 g - 380 g	B	-	7	0.7
Athene noctua	Little owl	164 g	B	-	1	-
Asio otus	Long-eared owl	275 g	B	-	2	-
Asio flammeus	Short-eared owl	350 g	B	-	3	0.3
Bubo bubo	Eagle owl	2.8 kg	C	-	1	-
Tyto alba	Barn owl	315 g	B	-	2	-
APODIFORMES						
Apus apus	Swift	40 g	A	1	26	2.6
PASSERIFORMES						
Alauda arvensis	Skylark	40 g	A	-	17	1.7
Hirundo neoxena	Welcome swallow	14 g	A	-	1	-
Hirundo rustica	Swallow	19 g	A	-	78	7.9
Caprimulegus europaeus	Nightjar	45 g - 100 g	A	-	2	-
Delichon urbica	House martin	17 g	A	-	4	0.4
Riparia riparia	Sand martin	13 g	A	-	3	0.3
Corvus sp	Crow	up to 530 g	B	1	14	1.4
Corvus corone	Carrion crow	530 g	B	-	2	-
Corvus frugilegus	Rook	430 g	B	2	7	0.7
Pica pica	Magpie	220 g	B	-	2	-
Turdus sp	Thrush	60 g - 125 g	A	1	3	0.3
Turdus pilaris	Fieldfare	98 g	A	-	1	-
Turdus merula	Blackbird	100 g	A	-	1	-
Turdus philomelos	Song thrush	50 g - 107 g	B	-	1	-
Motacilla alba	Pied Wagtail	23 g	A	-	1	-
Sturnus vulgaris	Starling	80 g	A	-	20	2.0
Carduelis chloris	Greenfinch	29 g	A	-	1	-
Carduelus Cannabina	Linnet	19 g	A	-	5	0.5
Passer domesticus	House sparrow	40 g	A	-	2	-
	Sparrow	18 g - 40 g	A	-	21	2.1
Fringilla coelebs	Chaffinch	15 g - 31 g	A	-	1	-
Plectrophenax nivalis	Snow bunting	35 g	A	-	1	-
Chiroptera	Bat	5 g - 20 g	A	-	1	-
UNKNOWN				69	783	
TOTAL				159	1776	

Notes: 4.1 Bird weights and Scientific Names are from 'Average Weights of Birds' by T Brough of Aviation Bird Unit, Worplesdon Laboratory, Agricultural Science Service, MAFF, Worplesdon, England. The average weight has been assumed.

4.2 The bird Categories based on current Civil Airworthiness requirements are:

A below 110 g (1/4 lb)
B 110 g to 1.81 kg (1/4 lb to 4 lb)
C over 1.81 kg to 3.63 kg (4 lb to 8 lb)
D over 3.63 kg (8 lb)

4.3 Those birds not positively identified are tabled as Unknown. Except where there is evidence that they are Large (C or D).

4.4 Percentages are based on incidents where birds are identified.

TABLE 5 PART OF AIRCRAFT STRUCK

INCIDENTS / PART STRUCK	BIRD WEIGHTS				TOTAL	% BASED ON 1878
	unknown	below 110g	110g to 1.81kg	over 1.81kg		
Fuselage	63	21	105	2	191	10.2
Nose (excluding radome and windshield)	118	63	121	-	302	16.1
Radome	89	39	85	1	214	11.4
Windscreen	116	67	119	-	302	16.1
Propeller	2	1	32	-	35	1.8
1 engine struck	128	35	172	5	340	18.1
2 out of 3 struck	-	-	2	-	2	0.1
2 or more of 4 struck	5	1	1	-	7	0.4
all engines struck	5	2	13	-	20	1.1
Wing / Rotor	88	17	168	6	279	14.8
Landing Gear	36	10	120	3	169	9.0
Empennage	9	1	7	-	17	0.9
Part unknown	58	24	142	3	227	-
TOTAL	717	281	1087	20	2105	100.0%

Notes: 5.1 The totals in Table 5 are higher than other tables as several parts can be struck in one incident.

5.2 The percentages are based on incidents where the part struck is known

5.3 Where both landing gear or both wings are struck, two incidents are recorded

5.4 110g = 1/4lb, 1.81kg = 4lb, 3.63kg = 8lb.

5.5 From one reporting country no data on parts struck available.

TABLE 6 Effect of Strike - 1984

Effect \ Incidents	Bird Weights: Unknown	Below 110 g	110 g to 1.81 kg	1.81 kg to 3.63 kg	Over 3.63 kg	Total	% Based on 1759
Loss of life/aircraft	-	-	-	-	-	-	-
Flight crew injured	-	-	-	-	-	-	-
Engine repairs on:							
2 engined aircraft	19	4	44	1	-	68	3.9
Others	29	-	26	4	-	59	3.3
Windscreen cracked or broken	3	-	3	-	-	6	0.3
Vision obscured*	4	-	1	-	-	5	0.3
Radome changed	4	-	3	1	-	8	0.5
Deformed structure	2	-	3	-	-	5	0.3
Skin torn/light glass broken	14	1	21	6	-	42	2.4
Skin dented*	20	4	20	1	-	45	2.6
Propeller/Rotor/ transmission damaged	-	-	-	-	-	-	-
Aircraft system lost	6	1	9	-	-	16	0.9
Take off abandoned*	5	-	6	-	-	11	0.6
Nil damage	555	169	763	7	-	1494	84.9
Unknown	21	1	7	-	-	29	-
TOTAL	682	180	906	20	-	1788	100%

Notes:

6.1 If, for example, skin is torn in two places, or both windscreens are broken, two incidents are recorded.

6.2 The percentages are based on known effects.

6.3* Not counted as damage

6.4 From one reporting country no data on strike effect available

Table 7 Aircraft Operators 1984

(A high strike rate may be due to efficient reporting)

OPERATOR	NUMBER OF INCIDENTS	NUMBER OF MOVEMENTS	RATE PER 10,000 MOVEMENTS
AUSTRIA			
Austrian Airlines	20	54,380	3.7
Tyrolean Airways	2	-	-
BELGIUM			
Sabena	13	72,048	1.8
Trans European Airways	1	5,926	1.7
Sobelair	1	8,068	1.2
CZECHOSLOVAKIA			
CSA	26	48,584	5.4
DENMARK			
Cimber Air	-	23,174	-
Conair	3	7,224	4.1
Gronslandsfly	-	29,376	-
Maersk Air	13	45,116	2.9
SAS	19	87,178	2.2
Sterling Airways	5	26,844	1.9
Other	1	14,268	0.7
FINLAND			
Finnair Oy	56	137,712	4.1
FRANCE			
Air France	88	297,233	2.9
Air Inter	167	161,844	10.3
U.T.A.	12	16,722	7.1
T.A.T.	7	89,288	0.8
IRELAND			
Aer Lingus	-	-	-
Irish Helicopters	1	-	-
Avair	1	-	-
ITALY			
Alitalia	224	158,636	14.1
NETHERLANDS			
KLM	85	118,658	7.2
NLM	10	57,900	1.7
Martinair	2	12,008	1.7
Transavia	6	-	-
NORWAY			
SAS	47	-	-
Braathen	6	-	-
Wideroe	4	-	-
Helicopter service	2	-	-
Fred Olsen	1	-	-
Busy Bee	1	-	-
Other	6	-	-
SWEDEN			
SAS	47	121,357	3.9
Linjeflyg AB (LIN)	28	124,000	2.3
Ostermans Aero AB	1	7,189	1.4
SWITZERLAND			
Swissair	138	-	-
Balair	11	-	-
Omo	1	-	-

UNITED KINGDOM

Air Atlantique	-	3,480	-
Air Bridge Carriers	2	6,286	3.2
Air Ecosse	8	18,018	4.4
Air Europe	13	21,812	6.0
Air UK	18	75,118	2.4
Airways Int (Cymru)	-	2,308	-
Anglo Cargo	-	356	-
Birmingham Executive	1	7,418	-
Bristow Helicopters	4	46,887 hrs	0.8
Britannia Airways	91	72,836	12.5
British Aerospace	8	-	-
British Air Ferries	6	18,448	3.2
British Airways	143	380,592	3.7
British Airways Helicopters	5	26,772 hrs	1.9
British Caledonian Airways	43	69,498	6.2
British Caledonian Helicopters	2	9,812 hrs	2.0
British Island Airways	1	7,984	-
British Midland Airways	37	78,978	4.7
Bryan Aviation	1	188	-
Brymon Airways	2	26,394	0.7
Channel Express	1	6,334	-
Dan-Air Services	47	117,988	4.0
Euroair Transport	1	1,690	-
Euroflight	-	3,464	-
Ford	3	-	-
Genair (Lease Air)	7	15,318	4.6
Guernsey Airlines	1	3,770	-
Heavylift Cargo Airlines	-	964	-
Janus	3	N/A	-
Jersey European	-	2,288	-
Loganair	8	9,922	8.1
Manx Airlines	20	16,310	12.3
McAlpine	1	-	-
Metropolitan Airways	-	4,028	-
Monarch Airlines	13	21,688	6.0
North Scottish Helicopters	-	7,594 hrs	-
Orion Airways	25	24,576	10.2
Peregrine	2	-	-
Tradewinds Airways	1	2,428	-
Venture Airways	-	488	-
Virgin Atlantic	-	662	-
Other Operators	14	-	-

Note: 7.1 Leased aircraft are included against the operator.

BSCE 18
Copenhagen, May 1986

REPORT OF THE CHAIRMAN

Monday, 26 May 1986

For the second time in the history of BSCE and with an interval of 15 years we are having a meeting in Denmark. Although the flag decoration of the City is not in honour of our meeting, but in honour of the 18 years' birthday of Crown Prince Frederik, I can assure you that the Danish authorities take a great interest in the work of this Committee. Evidence of this fact is that Denmark has undertaken to start the procedure to present the working paper dealing with harmonization of the ICAO Documentation on Bird Hazards to aircraft, which has been discussed at several BSCE meetings, to the Secretary General of ICAO. This has been done, and I am happy to report that Denmark was followed by the other Scandinavian countries, by Switzerland, Belgium, and the Netherlands. At a Plenary meeting Thursday or Friday the ICAO Representative will further inform us of the outcome of this effort.

Since our meeting 19 months ago, the members of your Steering Committee have only met once. It was in Paris last October, but your chairman has been in touch with the other members of the Steering Committee, and had the opportunity to meet the vice chairman and the liaison officer on several occasions.

The main purpose of the October meeting last year was to make preparations for this meeting, and I was very pleased that the Steering Committee meeting was attended by all Steering Committee members, except the chairman of the Structural Testing Group, who at that time had not not appointed by the French Administration.

You may have noticed some changes from our previous way to structure a meeting. Already at the Rome meeting, we decided that all papers should be produced and submitted before the meeting, and under the inspiration of our colleagues from US, we further decided that we should endeavour to publish working papers received before a certain date in a bound set to be given to the participants at the beginning of the meeting. I am fairly satisfied that 15 working papers covering 132 pages were received before 15 April. I hope that in future we shall do even better, and that even participants from the hosting country and Steering Committee members in the future will meet the date. The remaining 6 papers, which have been received today, are found in the meeting file that you collected when you registered.

At the Steering Committee meeting it was further decided to have a special sub-group established to discuss such problems as low-level flights by military aircraft. From the agenda among your papers you will see that such a meeting will be held on Tuesday afternoon, and I am happy to report that Col. Schneider of Denmark, a real old-timer amongst us, will be the rapporteur from that meeting and will present us with the result of the meeting at a later stage.

Further, it was decided that the Chairman should invite manufacturers to present the work done to minimize the risk of bird strikes, and I am pleased that M. Brémond from Aerospace Helicopter Division has been able to appear at this meeting to present his view. At later meetings we hope to succeed in persuading other manufacturers to present their views.

At the Steering Committee meeting we also had a thorough discussion of a problem which arose from the fact that the working paper presented at the Rome meeting on European Civil Aircraft Bird Strikes in the latter part of the 1970's, which was presented to the ECAC Technical Meeting, caused a problem in one country, especially as the figures could be interpreted in a way that the said country was doing very little to reduce the bird strike risk, whereas the real explanation to the high figure is due to the very well organized reporting system. The said country announced that in future it would only report bird strikes with damage, but as such an attitude would make it very difficult to continue the work within the Analysis Working Group, the Chairman wrote to the Minister of Transport in the said country and informed him that certain steps had already been taken to re-write the Analysis working paper and to stress the fact that a high strike rate is due to efficient reporting. I further stated that the chairman of the Analysis Working Group had agreed that the figure showing strike rate by country will be deleted from all future BSCE working papers and to delete figures showing airport bird strikes or alternatively to add a note to each figure reading that high numbers are due to efficient reporting. I expressed the hope that this change and several other changes which I will omit on this occasion, would persuade the said country to reconsider its decision to withdraw its co-operation providing all data to BSCE and ICAO on non-damaging strikes, indicating that it would be a pity if co-operation on these international systems for information on this significant economic and safety hazard were to break down.

We are looking forward to having a report on the outcome of the discussion within the said country.

I will now turn to give a report of the activities of the various BSCE working groups.

The **Aerodrome Working Group** was left with only one recommendation from the Rome meeting. It deals with the EEC directive on the conservation of wild birds, especially Article 9, para. 3, and the recommendation reads as follows:

"The Committee recommends to EEC Member States

(a) to keep the chairman and the liaision officer informed of the report sent to the EEC Commission about the implementation of the directive 79/409,

(b) to maintain contact with the chairman and the liaison officer in case the EEC Commission will promote action in the field affected by the BSCE recommendations."

To my knowledge the relevant authorities in the now 12 EEC countries are still not quite aware to what extent the EEC Secretariat wishes to have reports, but at least Denmark has reported to the Commission. You will have an English translation (WP 20).

The Working Group has had a new chairman, Mr. Heiko Helkamo of Finland, and he has been busy collecting material for the 3rd edition of the booklet on "Measures to Reduce Bird Risks Around the Airport". We are looking forward to being informed of his results.

Next comes the **Analysis Working Group** which was left with 5 recommendations from the Rome meeting.

1. The first one was that a sub-group be set up to pursue the work on the identification of bird remains with emphasis on microscopic remains of feathers. Our colleague, Mrs. Laybourne, from the US would act as rapporteur.

   We are looking forward to having reports from the sub-group, knowing that Mrs. Laybourne is present during this meeting.

2. The second recommendation left to the Analysis Working Group was the following:

   A special investigation should be carried out on the incidents where more than one engine was struck on take-off by birds with particular emphasis on bird species, number of birds striking the engine, and probable thrust loss.

The special investigation of incidents involving engine damage was agreed by correspondence with appropriate working group members. It was then discussed at an ICAO IBIS advisory group meeting in Montréal in June last year. At the request of IATA, the inquiry was expanded to include information on costs. ICAO State Letter of 27 September 1985 requested states to implement a supplementary report form covering this aspect.

3. The third recommendation was that ICAO be again encouraged to make some refinements to the IBIS programme in order to achieve full potential from this valuable system.

   As a result of the advisory group meeting in Montréal in June 1985, a number of refinements have been made to the IBIS system to improve its usefulness, such as

   - the mean bird weights are now being added to the computer record using our old friend Ted Brough's list;
   - the columns of bird species will be by order with the less common ones grouped together with exception of separate columns for all gulls and all lapwings. This will mean that the other column should be zero;
   - a injury index would be added to the world and states analysis;
   - the serious list would exclude loss/damage to one engine unless there is fire or uncontained;
   - the serious list would include events costing 100,000 dollars or more
   - removal of light aircraft to from world and states analysis, but not from reporting, is being considered;
   - windshield or airframe penetration would be amended automatically to include airspeed and altitude;
   - it was finally agreed that the addition of aircraft/airport movements to give rates was not possible on a global basis, but individual states can do this if they are able.

4. The fourth recommendation for the Analysis Working Group was that the working group chairman discussed by correspondence a definition of "on and/or near aerodromes in order that correct and comparable bird strike analysis is obtained."

The definition of these words was circulated for comments to appropriate working group members. As a result, proposals were put to the ICAO Advisory Group meeting and some trial computer outputs were used to assess the results. At the Steering Committee meeting in Paris in October, the following was agreed as being the best compromise:

ON	0-500 FT on climb	- 200-0 FT on approach
NEAR	501-1500 FT on climb	- 1000-201 FT on approach
EN ROUTE	1500 FT and above on climb	- above 1001 FT on approach

Apart from this recommendation, the working group chairman has consulted the military representatives on the need to continue with the analysis of bird strikes to military aircraft, but has had only little response.

Further information has been collected from many countries to produce an analysis of European registered civil aircraft 1983 to be distributed at this meeting. We are looking forward to having this paper in the Analysis Working Group, but some analysis were not available to produce the 1984-paper, and it has been observed that some countries have not produced the results in BSCE-format. Finally, the working group chairman has produced serious bird strikes to civil aircraft 1984 and 1985 using BSCE and other information.

Regarding the activities of the **Bird Movement Working Group**, I will first recall that the terms of reference are study of bird concentration and movements and drawing up of special bird hazard maps for informal and planning purposes.

During the last years, some types of bird concentration and migration methods have been developed, published and used. Most of these maps are, however, dating from 1974 to 1978, and in the meantime countries have gained new experience and knowledge about bird movement and bird concentration. Therefore it appears necessary to make a revision of the maps, especially the maps dealing with a national concentration and migration. Moreover, as an increasing number of bird strikes occur in the airport facility, the working group has found it suitable to draw up risk maps for such areas where such maps do not already exist.

Because of the increasing importance that the public attaches to wild life reserves, sanctuaries and moist areas of international importance according to the RAMSAR Convention, the working group has found it suitable to have one

single European map or some national maps as they are found in for instance Belgium, indicating geographical coordination, risk periods, bird species, area specification as well as an estimation of the number of birds. Such maps could be important for military low-level flights as well as for sports flying.

At the Rome meeting it was agreed that countries should name delegates for this working group, and at the meeting in the working group we will be informed of the answer to this appeal from the working group chairman.

Regarding the working group of **Communication and Flight Procedures**, you will recall that the working group was asked to collect data encompassing methods used for transmission of bird hazard information and flight procedures suggested to reduce or avoid bird strikes to be published on the lines selected by the Aerodrome Working Group in its yellow-green booklet. It was further agreed that standardization of flight procedures for helicopters, light aircraft and military low-flying aircraft could be or might be contemplated whenever possible.

As you will see from the agenda, we have for this meeting established a special sub-group on low-level military aircraft to deal with certain problems.

At the Rome meeting no special session of the **Radar Working Group** was held, because neither the chairman nor the vice chairman was able to attend the meeting.

The recommendations retained from the Moscow meeting focussed on:

a) Further efforts towards coordination and collaboration in
   (1) the field of radar research in bird migration
   (2) in the operational use of radar information for bird strike prevention.

b) Promotion of a mutual exchange of radar information on actual mass migration of waterfowl between Russia and Finland.

c) Inclusion of Austria in the radar chain along the Alps.

ACTIVITIES

International cooperation

Cooperation in radar research

- In a colloquium at the Swiss Ornithological Institute in spring 1985 T. Alerstam, L.S. Buurma, H. Biebach, L. Jenni and B. Bruderer discussed radar

and trapping data concerning strategies of migrating birds crossing unhospitable areas.

- The context "Crossing of unhospitable areas" is the frame of a large project (supported by the Swiss National Science Foundation) aimed at the study of "Strategies for migrating birds crossing the Sahara desert". Due to the political problems in the Near East and in Northern Africa this project (in cooperation with Egypt and Germany) cannot start this autumn, but will - inshalla! - be realized in autumn 1987.
- The inclusion of Austria in the radar chain along the Alps was not possible. However, data from Germany (Munich), France (Basle-Mulhouse), and Switzerland (Zurich and Geneva) led to a better understanding of migration along the northern border of the Alps (Baumgartner & Bruderer 1985 in: Orn. Beob. 82: 207-230).
- In a further attempt to get Italy involved in the radar studies on bird migration, information on methods for recording bird migration by means of surveillance radars was sent ot the "Istituto Nazionale di Biologia della Selvagina" at Bologna (January 1986).

Cooperation in the operational use of radar for bird strike prevention

- The letters sent to the Russian and Finnish authorities after the Moscow meeting, in order to realize a mutual exchange of radar information on mass migration of waterfowl, have apparently caused some effect. A letter (28.8.86), signed by Shergalin Jevgeni, gave the information (1) that a radar working group was established in the Sovjet Union in January 1985, (2) that this body has made some spadework in the field of a mutual exchange of information with Finland, and (3) that J. Shergalin was starting a thesis work on "Bird behaviour control for the security of aircraft flights in Estonia".
- L.S. Buurma is looking for improvements (especially refinements of the altitude information) in BIRTAMS exchanged between NATO countries.

Improvement of radar information on bird migration

Altitudinal distribution of bird migration

- Problems of measuring bird densities at different altitudes have been one of the main subjects in the work of the group.

- Most emphasis has been put on the distribution of birds in the lowest levels. Improvements of the methods separating bird densities in the lowest air layers can probably be presented at the Copenhagen meeting.

Horizontal distribution of migrating birds

- Deviations of migrating birds by topographical features may cause local or regional concentrations of birds. Large-scale deviations of the stream of nocturnal migrants are shown by the radar chain along the Alps (see above), local deviations are demonstrated by tracking radar studies at the very border of the Alps (Liechti & Bruderer 1986 in: Orn. Beob. 83: 35-66), and reactions of selected raptor species to topography are elucidated by combined tracking radar and visual studies (Schmid, Steuri & Bruderer 1986 in: Orn. Beob. 83 in press).

BOOKLET ON THE "USE OF RADAR FOR BIRD STRIKE REDUCTION

A draft (including the new results on low level concentrations of birds) is in preparation and will be presented at the Copenhagen meeting.

As you will recall, the **Structural Working Group** at our last meeting was faced with the problems that Peter Richards had to resign. It took some time to find a new chairman, but as a Christmas gift to the Committee I was informed a week before Christmas that the French authorities had agreed that Pierre Chalot, who is an engineer, from CEAT in Toulouse would take up this job and I am very happy to welcome Mr. Chalot to this meeting.

The new chairman has worked hard and has informed me that unfortunately he has not been able to make contact to the non-French members of the working group, but the following studies are in progress since our last meeting:

Bird strike tests on Aramid Epoxy Composite Structures are being done in the facilities in Toulouse and this paper will be presented in the working group. I refer to working paper 2 in our bound set. Further, some tests have been performed also in Toulouse to study low-temperature effect on the resistance of various wind shield glasses. This work is still in progress. And finally that NIDA and shock absorber materials' bird strike resistance are also being tested. These topics are planned in the preliminary of the manual for the design of bird impact resistance structures and transparances.

One aspect of the work of our Committee must not be overlooked, and this is the cooperation with other international organizations and especially ICAO and ECAC. I have already dealt with our work regarding the harmonization of the ICAO documentation on bird hazards, and we are happy to see John Widdall from the ICAO Paris office between us. He will inform us of the latest development regarding the treatment of that paper within the ICAO machinery. The chairman of the Analysis Working Group has worked closely with ICAO regarding the IBIS system, and we will be informed of the outcome of this work within the Analysis Working Group and later on Thursday or Friday, the Plenary.

During the 19 months since we met in Rome, one ICAO workshop in the region has taken place. At the meeting in Bangkok the Committee was represented by the liaison officer and the chairman of the Bird Movement Working Group. I am confident that John Widdall can reveal ICAO plans of further workshops, and as far as I am informed, there is a possibility to have workshops both in the Carribian South American region and in East Africa.

BSCE is also working together with ECAC, and you will remember that ECAC has asked member states to use the BSCE document on bird strike risk reduction at airports. We are happy to greet Mr. Michael Dietz and Mr. Erik Thrane, IATA, and it will be evidence of the importance IATA attaches to our meetings.

Finally, I would like to inform you on the planning of future BSCE meetings. The 19th meeting of Bird Strike Committee Europe will be held in the spring of 1988 somewhere in Spain, and at the 20th meeting we shall again go north and hopefully be in Finland.

Before the Chairman adjourned the first Plenary meeting, he gave information on some practical details and expressed the hope that the meeting would be successful.

BSCE 18 Copenhagen

28 May 1986

Revised Version

ANALYSIS WORKING GROUP - CHAIRMANS PROGRESS REPORT

1. Recommendations from 17th Meeting, Rome, October 1984

(1) That a Sub-Group be formed to pursue the work on the indentification of bird remains with emphasis on microscopic remains of feathers.

(2) That special investigation should be implemented of incidents where more than one engine was struck on take-off by birds, with particular emphasis on bird species, number of birds striking the engine and probable thrust loss.

(3) That ICAO be again encouraged to make some refinements to the IBIS programme in order to achieve full potential from this valuable system.

(4) That the Working Group Chairman discuss by correspondance a definition of ON and NEAR aerodrome in order that correct and comparable bird strike analysis is obtained.

(5) That the Structural Testing Working Group note:

- the high proportion of damage to radomes;
- the low probability of a bird of over 1.8kg(4lb) striking the tail of an aircraft.

2. Implementation of Recommendations

(i) The sub-group on Feather Remains was duly formed with Mrs R Laybourne of the Smithsonian Institution as the Rapporteur. The aims and objectives of the sub-groups have been defined.

(ii) The special investigation of incidents involving engine damage was agreed by correspondance with appropriate working group members. It was then discussed at an ICAO IBIS Advisory Group meeting in Montreal in June 1985. At the request of IATA the enquiry was expanded to include information on Cost. ICAO state letter AN4/9.1-85/67 of 25 September 1985 requested States to implement a Supplementary Report Form, covering these aspects.

(iii) As a result of the Advisory Groups meeting in Montreal a number of refinements have been made to the IBIS System output to improve its usefulness:-

- the mean bird weights are now being added to the computer record, using T Brough's list.
- the columns of bird species will be by Order (with the less common ones grouped together) with the exception of separate columns for all gulls and all lapwings. This will mean that the 'Other' column should be zero.

- an injury index would be added to the World and State Analysis.

- the Serious List would exclude loss/damage to one engine, unless there is fire or uncontained.

- the Serious List would include events costing $100,000 or more.

- removed of light aircraft from World and State analysis but not from reporting, is being considered.

- windshield or airframe penetration would to automatically include airspeed and altitude.

- it was agreed that the addition of aircraft/airport movements to give rates was not possible on a Global basis, but individual States could do this if they were able.

3. Discussions at 18th Meeting, Copenhagen

(a) Using information supplied by members (and other sources) the Chairman produced WP/4 "Serious Birdstrike Incidents 1984/1985". Several events were highlighted, the B737 nose penetration in South Africa was a Blue Crane (Anthropoides paradisea) weight 3.5 kg. The B747 incident in New Zealand was caused by Oyster catchers (Haematopus ostralegus weight 500 g). Two engines were shut down shortly after take-off, and one other engine was also damaged. This incident was close to being a major accident. The B737 uncontained ingestion incident at Dublin had cost $2 million.

(b) WP/31 "Military Bird Strike Analysis 1983/1984" by Squadron Leader C Turner of RAF was presented. Only 5 countries had been able to provide data. In the data sample four aircraft had been lost.

(c) The Chairman presented WP/21 "European Civil Aircraft Bird Strike Analysis 1983". It was stressed that a high strike rate may be the result of efficient reporting and may not be the result of poor aerodrome measures. In 1983 122 engines were damaged, emphasising it is costly and a hazardous problem. Using German cost data for 1983, it is possible that for all European airlines the cost of bird strikes could be as high as $14 Million.

Discussions on the paper, in particular the purpose, revealed that Germany would be unwilling to provide data for strikes by Country, Aerodrome and Airline as it appeared to imply a lack of effective measures. This was because different countries had variable standards of reporting, and some data were only meaningful if all countries had the same standard. They would continue to report on damaging strikes. as proposed by Switzerland that each airline should provide their strikes and movements at airports in their system. Examination of these data would indicate problem airports. It was also suggested that the IBIS System should be used, but it was noted that it was not possible to incorporate movement data on a global scale.

It appeared that most countries were happy to continue with the present analysis system, and it was therefore decided to continue since at present some of the tables do not contain data from all countries whereas others are complete. The 1984 Analysis may be available with the meeting report.

(d) A brief presentation on "Strategies for Identification of Bird Remains" was given by the Belgian Air Force. This work on blood and meat remains is being done by Professor Dr De Bont, Department of Biology, Section Systematic & Ecology, Naamsestraat 59,B3000 Leuven, Belgium.

(e) A paper, WP/8, "1983/1985 USAF Bird Strikes" was given by a representative of the US Airforce, Mr J Short. It showed the various factors that could be concluded from the 5000 strikes reported.

(f) The new ICAO Supplementary Report Form had been disseminated with ICAO State Letter AN 4/9.1 - 85/67. The UK had included a reference to the usefulness of photos.

(g) In order to remind people of the need to send data on strikes to other countries, a recommendation was proposed with a list of appropriate contact persons and addresses.

(h) Discussion on the definition of ON and NEAR an airport so that better bird strike data could be produced resulted in an agreed arbitrary definition, see recommendation No 2. It was agreed that the new definition could be applied to the 1985 statistics.

(i) The purpose and usefulness of the military analysis was discussed. Owing to problems of confidentiality and the fact that many countries did not provide information, it was decided that the German Military Geophysical Office would undertake future military analysis work, and all were asked to send this directly to Dr Hild. It was to be sent within 6 months, in the same format as currently used.

(j) It was agreed that updated civil analysis Master Tables would be provided by the Working Group Chairman, and that the civil data should be sent to him within 6 months (1st Nov 1986).

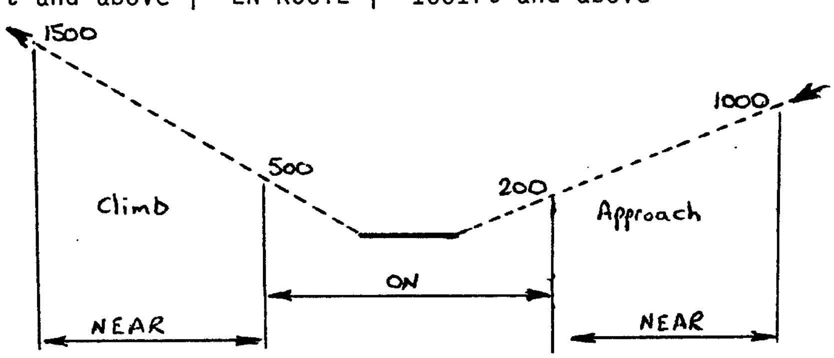
4. Recommendations

1) All Working Group members are reminded that details of strikes to their own countries' aircraft which occur outside their own country, should be sent to the relevant person in the country in which it occurred.

Note: A list of names and addresses is to be provided.

2) That all members use the following criteria in defining whether a civil strike is ON or NEAR an airport:-

CLIMB		APPROACH
0 to 500ft	ON	200ft to 0
501 to 1500	NEAR	1000ft to 201ft
1501ft and above	EN ROUTE	1001ft and above



3) That maintenance personnel be reminded that whenever evidence is found of a bird strike, this should be reported on the bird strike reporting form, and any feathers or remains be sent to the appropriate person for analysis.

4) That the BSCE Analysis of 1985 Data incorporating ON, NEAR and DAMAGE, be sent by 1st November 1986 to

   - Chairman (J Thorpe) for Civil Analyses

   - Dr J Hild for Military Analysis

   Note: Details of any serious incidents to civil aircraft should be sent to the WG Chairman as soon as possible after the event.

John Thorpe
Analysis WG Chairman

Report from Sub Group on Feather Indentification

The subgroup on feather identification had its first meeting.

There were about 15 members in attendance. The group discussed the variations of the microscopic structure of the down of several species of European birds and methods of preparation of the specimens for Scanning Electron Microscopic Study. It was agreed to exchange information on feather identification and to ask each country to let the group know who in each country is doing the feather identification.

May 1986

LIST OF ADDRESSES - CIVIL

The addresses below give the appropriate person who should be sent a copy of bird strikes reported

- in your country to aircraft from that country
- to aircraft on your National Register which are struck in that country

AUSTRIA

Ministry of Transport
Radetzkystrasse 2
A-1030 Vienna
AUSTRIA

Attn Dipl Ing G Matschnigg

BELGIUM

Operations Division
Ministry of Communications
Administration de l'Aeronautique
Centre Communication Nord
4th Floor
Rue du Progres 80 Coite 106
1210 Brussels
BELGIUM

Attn Mr M Haerynck

DENMARK

Civil Aviation Administration
Luftfartshuset
Postbox 744
Ellebjergvej 50
DK-2450 Copenhagen NV
DENMARK

Attn Mr H Dahl

FRANCE

Service Technique de la Navigation Aerienne
246 Rue Lecourbe
75015 Paris
FRANCE

Attn M J L Briot

FINLAND

Chief, Flight Operations Section
National Board of Aviation
Box 50
SF 01530 Helsinki-Vantaa-Lento
FINLAND

Attn Mr R Lamberg

GERMANY

German Birdstrike Committee
5580 Traben-Trarbach
Froschenpuhl 6
WEST GERMANY

Attn Dr J Hild

IRELAND

Dept of Communications
Kildare Street
Dublin 2
IRELAND

Attn Mr V Fehan

ITALY

BGAC-Piazzale Degl Archivi
00100 Rome
ITALY

Attn Mr E Luzzatti

NETHERLANDS

Dept of Civil Aviation
Plesmanweg 1-6
2597 JG The Hague
NETHERLANDS

Attn Mr H J D Van Wessum

NORWAY

Zoological Musuem
Sarsgt 1
N-0562 Oslo
NORWAY

Attn Mr P G Bentz

SPAIN

Laboratorio OAAN
Medio Ambiente Aeroportuario
NTRA SRA De la Soledad SN
Barajas
Madrid 28022

Attn Mr Pablo Morera

SWEDEN

Board of Civil Aviation
Fack
S601 79 Norrkoping
SWEDEN

Attn Mr L O Turesson

SWITZERLAND

Swissair TITM
CH8058 - Zurick Airport
SWITZERLAND

Attn Mr H Barth

TURKEY

Mr Hayri Korkut
Head of Technical Division
Ulastirma Bakanlion
Ankara
TURKEY

UNITED KINGDOM

Safety Data & Analysis Unit
Civil Aviation Authority
Brabazon House
Redhill
Surrey
RH1 1SQ
England

Attn J Thorpe

BSCE 18 Copenhagen
May 1986

AERODROME WORKING GROUP - CHAIRMAN'S REPORT

1. Agenda

The following agenda was adopted:

a) Adoption of the agenda.
b) Recommendations of the previous meeting.
c) Revision of the green booklet.
d) Presentation of working papers.
e) The green booklet (continued).
f) Other items.

2. Recommendations of the previous meeting

- This recommendation regards the fulfilment of the obligation to apply the EEC Directive on the conservation of wild birds and especially art. 9, para. 3, of this directive.
- Only one reply (from Denmark) was received. This reply is given in WP 20.
- Mr. Dahl reports that a discussion on this point is foreseen in agenda point 5.1 of the Plenary meeting. Due to the workload of the Working Group, the discussion on this point is postponed and will take place at the Plenary meeting.

3. Revision of the green booklet

During the 17th BSCE meeting in Rome, a majority of BSCE members believed that an updating of the green booklet was necessary.

The chairman of the Working Group sent out a letter asking for how to make the information more concise and relevant and in the second place to provide new information.

Replies from 15 countries have been obtained and information from countries which have not answered can be forwarded within 2 months from now.

Mr. Stenman has made a preliminary revision of the booklet.

In relation to the presentation the old method has been kept. Some countries were asking to keep this presentation, others suggested a new form.

A new proposal shall be sent out at the end of this year for approval at the next meeting.

4. Working papers presented

- WP 3: Properties of the auditory system in birds and the effectiveness of acoustic scaring.
  By K.J. Beuter and R. Weiss.
  Followed by an exchange of views.
- WP 9: Toxic perches for control of pest birds in aircraft hangars.
  By M.M. Thompson and T.J. Will.
  Followed by an exchange of views.
- WP 6: Frightening devices in airfield bird control.
  By R.P. DeFusco.
  This slide tape presentation is available for BSCE members.
- WP 19: The problem of black-headed gulls breeding near airports.
  By H. Lind.
  Followed by an exchange of views.
- WP 34: Study structure of bird and ecosystems in Spanish airports.
  By J. Ruiz and P. Morera.
- WP 33: Increase of efficiency of the mobile Bio-Acoustic system for scaring birds within the airport area.
  By B. Efanov.
- WP 18: Last French experiments concerning bird strike hazards refuction (1981-1986).
  By J.L. Briot.
  Followed by an exchange of views.
- WP 24: A granulated insecticide to control invertebrates on airfields.
  By T.A. Caithness.
  Followed by an exchange of views.
- WP 27: Bird hazard at Ben-Gurion Airport.
  By I. Agat and S. Suaretz.

5. Other items

- Some announcements made by the BSCE chairman.
- Belgian delegation asks to other delegations for names and addresses of pyro-technic device producers.

6. Recommendations

- A recommendation was received from the Communications and Flight Procedures Working Group for eventual approval in the Aerodrome Working Group.

  It reads as follows:

  "Excessive or repetitive bird risk warnings of any kind rapidly cease to serve any practical, operational purpose and should preferably be avoided. In the case of static bird concentrations on or near aerodromes, appropriate measures from the BSCE booklet "Some measures used in different countries for reduction of bird strike risk around the airport" should be applied."

  The BSCE chairman proposed to discuss the adoption of this recommendation after hearing the Communications and Flight Procedures chairman's report at the Plenary meeting.

  Some countries felt that this recommendation has not to be taken over in this Working Group.

The Aerodrome Working Group chairman

BSCE 18 Copenhagen
May 1986

RADAR WORKING GROUP - CHAIRMAN'S REPORT

1. Title: Radar and other sensors.

2. Terms of Reference: Matters associated with the use of radar and other sensors in the surveillance, the identification and the assessment of bird presence and movements.

3. Progress Report:

3.1 Work done since last meeting

3.1.1 International cooperation

- The inclusion of Austria into the radar chain along the Alps was not possible. However, data from Germany (Munich), France (Basle-Mulhouse), and Switzerland (Zurich and Geneva) led to a better understanding of migration along the northern border of the Alps (Baumgartner & Bruderer 1985: Orn. Beob. 82: 207-230).
- In a further attempt to get Italy involved in the radar studies on bird migration, information on methods for recording bird migration by means of surveillance radars was sent to the "Istituto Nazionale die Biologia della Selvagna at Bologna."
- The letters sent to the USSR and Finnish authorities after the Moscow meeting, in order to realize a mutual exchange of radar information on mass migration of waterfowl, have led to promising contacts between the two countries.

3.1.2 Improvement of radar information on bird migration.

- In the Netherlands and in Switzerland most emphasis has been put on measuring bird densities at different altitudes, especially at the lowest levels.
- In Belgium the BOSS-system using plotlines and fast replays, has now reached the operational stage in the Belgian Air Force measuring bird intensities at different altitudes.

- Large-scale deviations of the stream of migrants along the northern border of the Alps are shown by the chain of surveillance radars mentioned above. Local deviations are demonstrated by tracking radar studies exactly at the border of the Alps (Liechti & Bruderer 1986 in: Orn. Beob. 83: 35-66), and reactions of selected raptor species to topography are revealed by combined tracking radar and visual studies (Schmid, Steuri & Bruderer in: Orn. Beob. 83 in press).
- A draft booklet on the use of radar for bird strike reduction was prepared for the Copenhagen meeting.

3.2 <u>Work done during the meeting</u>

- J. Becker (FRG) presented a paper on "The use of radar for bird strike prevention in Germany" (WP/5). In the discussion it was emphasized that in the majority of ATC operational surveillance radars, most of the bird echoes are filtered out, and that it is important to have an indication of the proportion of echoes retained. The selection usually eliminated smaller birds and birds at lower levels. No or only very limited information is available on altitude distribution.
- G. Dupont (Belgium) commented a video movie on the "Bird Observation System Semmerzake. B.O.S.S.". The improvements of this system compared to simple surveillance radars are (1) an improved altitude information and (2) electronic determination of echo strength and density. During the discussion it was stated that an altitude discrimination of only 2000 ft is not the optimum for operational use, and that, again in this system, only small part of the bird echoes are seen on the screen. The question is whether the echoes on the screen are caused by the most dangerous birds (large birds, large flocks).
- R.P. DeFusco (USA) commented an impressive series of slides on "Bird hazard warning using Next Generation Weather Radar" (WP/7). It became clear that the extreme resolution capacity of these radars in all three dimensions, combined with a sophisticated colour representation of radial speed and echo intensity offers completely new possibilities for a three dimensional picture of bird migration.

- A draft booklet "The Use of Radar for Bird Strike Reduction" was discussed. A smaller group was formed in order to continue the work between this and the next BSCE meeting.
- The proposal of the chairman to retire and to leave the chair to the vice-chairman, L.S. Buurma, was accepted. As nobody was willing to take over the task of the vice-chairman, B. Bruderer offered to undertake this task for some years instead of the chairmanship.

4. Recommendation:

   a. The Working Group recommends that Finland and the Soviet Union should continue to improve the mutual exchange of actual radar information on mass migration of waterfowl in areas of common interest.

   b. The Working Group expressed the wish that the booklet "Use of Radar for Bird Strike Prevention" should be prepared for the next meeting of BSCE.

Bruno Bruderer

BSCE 18 Copenhagen

May 1986

BIRD MOVEMENT WORKING GROUP - CHAIRMAN'S REPORT

1. Title

Bird Movement Working Group

2. Terms of Reference

Study of bird concentrations and movements, drawing up of special bird hazard maps for informal and planning purposes, and develop preventive measures to minimize the bird hazard to low flying aircraft.

3. Progress report

a) The Working Group elected Dr. Becher, GMGO, as new vice-chairman and named responsible members for the single countries in order to re-activate the work of the group.

b) Some countries are revising the national bird concentration maps so that a new map collection may be published within the next 4 years; therefore, it could become necessary to revise the bird strike risk maps for national AIP, too.

c) There was a discussion about two other types of maps and that

- Map collection about sanctuaries, wildlife reserves, national parks of ornithological importance and moist areas of international importance.
- Map collection about bird concentrations in the airport vicinity according to special guidelines.

Some countries have such maps available or in planning. Publication is provided. Countries will decide in own responsibility whether there is a need of such maps or map collection.

4. Future program

a) Collection of data about wildlife reserves, sanctuaries and moist areas of international importance as well as of national parks for all European countries.

b) Collection of data about bird concentration areas in the vicinity of international airports.

c) Revision of the existing bird concentration and migration maps for AIP purposes.

d) Development of preventive measures to minimize the bird hazard to low flying of aircraft.

5. Recommendations

a) Countries are requested to name persons/members for active co-operation within the working group.

b) Members of the working group are requested to revise existing national maps and to give corresponding comments to the chairman of the working group. Deadline: 1st January, 1988.

c) Countries are requested to work up information about sanctuaries, national parks of ornithological importance and moist areas of international importance for drawing up a corresponding European map. Chairman WG will send corresponding questionnaires within 2 month's time; they should be returned before 1st January, 1988. Countries should decide in own responsibility whether there is a need for publication of such maps.

d) Countries are requested to draw up airport vicinity maps in close co-operation with airport authorities and according to special guidelines which will be composed by the chairman and sent to the members within 2 month's time. Countries are requested to send corresponding information before 1st January, 1988 to the chairman.

BSCE 18 Copenhagen
May 1986

SUB-GROUP ON LOW-LEVEL MILITARY AIRCRAFT

Draft Recommendations

1. Forming of a Sub-group

The group decided neither to form a sub-group nor a Working Group. Instead, the Bird Movement Working Group was asked to put more emphasis on the bird hazard to low flying military aircraft.

2. Change of Terms of Reference

Consequential to Recommendation 1 it is suggested to add to the Terms of Reference for the Bird Movement Working Group:

"and develop preventive measures to minimize the bird hazard to low flying aircraft".

BSCE 18 Copenhagen

May 1986

COMMUNICATIONS AND FLIGHT PROCEDURES WORKING GROUP - CHAIRMAN'S REPORT

Terms of Reference

Study of all problems relating to the transmission of information on bird movements which could present a hazard to aviation and the provision of such information to air traffic services.

1. Recommendations of previous meetings

From BSCE/16

a) Contacts should be made by the working group chairman to explore if and when BIRDTAM be accepted for transmission via the meteorological network.

b) That, with due consideration of the tasks involved in selecting avoidance procedures, the groups should rely on the expertise of duly appointed representatives from international organizations, like AEA, IATA, ICAO, IFALPA, IFATCA, and WEAA.

c) That the future activities of the group should be aimed, as a prime object, to the preparation of a booklet recording the national practices and offering a standardized format.

d) The problem of quick BIRDTAM transmission and exchange between countries should be discussed during the next BSCE meeting. The chairman of WG Communications and Flight Procedures is invited to check the possibilities at ICAO for setting a higher BIRDTAM priority in the AFTN, for setting obligatory regulations as to the publication of BIRDTAMs, or to transmit BIRDTAMs on the network for meteorological transmission.

From BSCE/17

e) The collection of data encompassing methods used for transmission of bird hazard information and flight procedures suggested to reduce or avoid bird strikes, should be arranged for publication along the lines selected by the Aerodrome Working Group in its document "Some measures used in different countries for the reduction of bird strike risks around airports".

f) Standardisation of such flight procedures for helicopters, light aircraft and military low-flying aircraft may be contemplated, whenever possible.

2. Progress between 17th and 18th Meetings

The chairman circulated the questionnaire on which the work in paragraph 1 (e) above was to be based.

3. Papers presented at the working group meeting in Copenhagen

WP/13 Communications with the pilot

WP/29 Avoiding bird strikes

4. Discussions at the Copenhagen Working Group Meeting (BSCE/17 Recommendation 1)

4.1 In the absence of the Chairman and Vice-Chairman of the Communications and Flight Procedures Working Group, the chair was taken by Mr. John Widdall, a member of the steering committe of BSCE.

The discussions of this group at the Copenhagen meeting centred on the following topics:

a) Communications with the pilot (WP/13);

b) Bird strike avoidance procedures (WP/29); (Recommendation (b) from BSCE/16 and Recommendation (f) assigned by BSCE/17)

c) Warning operators of short-term bird strike risks (BIRDTAM) (Recommendation (a), (c), and (d) carried forward from BSCE/16)

d) Questionnaire on data encompassing methods; (Recommendation (e) assigned by BSCE/17)

Communications with the pilot (WP/17, Captain D. Renoux, Air Inter)

4.2 In the absence of Captain Renoux, the acting chairman presented WP/13 relating to communications with the pilot. The group fully supported the paper's plea for increased reporting of bird strikes, estimating that between 30% and 60% of strikes were not currently reported. Some reservations were, however, expressed about the paper's suggestion that "bird misses" (or near bird strikes) should also be reported in order to establish a larger statistical base, and the group emphasised that, to avoid confusion, this should certainly not be done on existing bird strike forms. In context of the options available to airline pilots warned by ATC of an increased bird strike risk, two instances were cited, one of an airline and one of an experienced pilot, whose policy was to delay take-off until bird strike risk reduction measures had been carried out.

4.3 Related legal aspects of bird strike prevention measures were also discussed and it was suggested that it might be more prudent for an air traffic controller to use a phrase such as "Bird clearance measures completed" rather than "Runway clear of birds". Mention was also made of two States in which judges had established the principle that an airport authority which had applied reasonable bird strike risk reduction measures should not be held liable for bird strike damage.

Bird strike avoidance procedures (WP/29, Mr.J. Thorpe, United Kingdom and Recommendation (b) from BSCE/16 and Recommendation (f) assigned by BSCE/17)

4.4 WP/29, "Avoiding Bird Strikes", was tabled by Mr. J. Thorpe and was a reprint of an article by Mr. M.J. Harrison of the FAA. Amongst other information, it contained a list of twenty recommendations relating to bird strike avoidance and post-strike actions and was intended for general aviation use. The group felt that the material contained useful guidance, but recognised a need to adapt certain parts of it to European conditions and terminology.

One such example concerned the use of landing lights, which it was felt were probably beneficial on balance, although two examples given questioned this philosophy. The group acknowledged the over-riding reason that landing lights were often required for ATC visibility and separation purposes and observed that, for bird strike prevention purposes, their use was equally valid on take-off and landing. Airline practice appeared to be generally standardised as wing or auxiliary landing lights below 10,000 ft and main landing lights until completion of take-off noise abatement and for the final stages of the landing approach.

Another such point concerned birds' vertical reactions to approaching aircraft. The larger ones at least were said to descend, but some evidence emerged from military helicopter bird strikes in the Federal Republic of Germany that ducks and pigeons may not react at all.

Mr. Thorpe agreed to act as rapporteur for the adaptation of this material for use by BSCE and to receive comments and reflect them in the material which would then be presented to the next meeting.

The group developed Recommendation 1 below.

Warning operators of short-term bird strike risks (BIRDTAMs)(Recommendations (a), (c), and (d) carried forward from BSCE/16)

4.5 Recommendations (a) and (d) carried forward from BSCE/16 had requested the chairman to liaise with ICAO on certain aspects of BIRDTAMs in preparation for the further discussion of this matter during the next BSCE meeting. The representative of ICAO informed the meeting that there were no current ICAO provisions relating to BIRDTAMs; that proposals for such new provisions could be presented by any ICAO member State; and that any such proposals should be drafted with either world-wide documentation (annexes or manuals) or the European air navigation plan in mind. During the subsequent discussions it transpired that some States had regulations for longer term warning of bird hazards such as annual migration, whilst others used NOTAMs for such purposes. Mention was also made of the well-developed military BIRDTAM system, principally amongst States bordering on the North Atlantic, and some States circulated military BIRDTAMs to civil users on a selective basis. Experience with the military system indicated that normal teletype transmission was too slow for the effective transmission of BIRDTAMs which it was emphasised were reports of real-time observations of birds and not predictions. It was suggested that the meteorological transmission network should be used. There was unanimous agreement on the need to develop a suitable warning system for short-term bird hazards, which might possibly be applied initially on a trial basis, and the group developed Recommendation 2 below.

4.6 Recommendation (c) carried forward from BSCE/16 was also considered to refer to BIRDTAMs. However, in the light of the information on States' practices which had emerged during the preceding discussions (paragraph 4.5), the group decided against proceeding with the compilation referred to, which it felt had been largely met by Recommendation 2 below.

4.7 Several speakers pointed out that repetitive warnings of bird hazards rapidly ceased to serve any operational purpose and clogged the system, obscuring genuine warnings. The group emphasised that before short-term warnings of bird concentrations on aerodromes were originated, every practicable bird dispersal measure should be attempted. To this end, the group formulated Recommendation 3 below.

Questionnaire on data encompassing methods (Recommendation (e) from BSCE/17)

4.8 In context of Recommendation (e) from BSCE/17, the group noted that the Chairman of the Working Group had despatched the related questionnaire on 2 May 1986. In consequence, the consideration of this matter was carried forward to the next BSCE meeting, when it was expected that the chairman would present the results of the questionnaire and corresponding proposals based upon them. This recommendation was therefore carried forward to BSCE/19 as Recommendation 4 below.

5. Recommendations

1. Development of Flight Procedures

That the article "Avoiding bird strikes" (WP/29) be circulated by the working group chairman to participants in the working group and chairmen of national bird strike committees as an example of potentially useful guidance material, in this case relating more specifically to general aviation. Comments for the adaptation of this material to BSCE's needs should be collected by the rapporteur, Mr. J. Thorpe, and, to the extent possible, the group should develop recommended bird strike avoidance and post-strike procedures for helicopters, light aircraft and military aircraft. In carrying out this work, the group should endeavour to obtain the active input of the duly appointed representatives of appropriate international and regional organizations, such as AEA, IATA, ICAO, IFALPA, IFATCA, IAOPA, and AACC.

2. Provision for warning of short-term bird strike (BIRDTAM)

The group should develop regional procedures for the rapid collection and transmission of information on those bird hazards to aviation which cannot be predicted in advance and which cannot be quickly dispersed by the available means. It is envisaged that this will involve the formal development of a civil "BIRDTAM" message and its implementation on a trial basis in co-ordination with the European Regional Office of ICAO. (Recommendation 3 - "The need to avoid over-using bird risk warnings" is also relevant.)

3. The need to avoid over-using bird risk warnings

Excessive or repetitive bird risk warnings should be avoided as they rapidly cease to serve any practical, operational purpose and reduce pilot awareness. In the case of static bird concentrations on or near to aerodromes, precise warnings and, in particular, appropriate measures from the BSCE booklet "Some measures used in different countries for reduction of bird strike risk around the airport" should be applied.

Note: BSCE is prepared to offer individual advice in cases where the nature of the problem and/or the lack of means or expertise prevents the quick resolution of a problem.

4. Data encompassing methods (BSCE/17 Recommendation (e))

The collection of data encompassing methods used for transmission of bird hazard information and flight procedures suggested to reduce or avoid bird strikes should be arranged for publication along the lines selected by the Aerodrome Working Group in its document "Some measures used in different countries for the reduction of bird strike risks around airports".

6. <u>Participation in Communications and Flight Procedures Working Group at Copenhagen</u>

DENMARK:	E.P. Schneider M.C. Lundberg H. Dahl
FEDERAL REPUBLIC OF GERMANY:	D. Brüssow Dr. Fürberg O. Hoffmann
FINLAND:	Seppo Kirjonen Ari Aho Heikko Helkamo
FRANCE:	A. Attig, J. Souquet J.L. Briot
IRELAND:	R.A. MacDonald
ITALY:	Cpt. A. Ferrari S. Nastro/Alitalia
NETHERLANDS, The:	C. Bakker
SPAIN:	Juan Trinidad Gabriel Diaz de Villegas Pablo Morera, A. Villuendas
SWEDEN:	Erik Hirschfeld L-O Turesson Sven-Harald Andersson/Linjeflyg
U.K:	John Thorpe
U.S.A.:	John L. Seubert Bert Biuings
IATA:	Michael Dietz/Lufthansa Erik Thrane/SAS
ICAO:	J. Widdall (Acting Chairman)

WORKING GROUP FOR STRUCTURAL TESTING OF AIRFRAMES - CHAIRMAN'S REPORT

1. Activities of the Group

The only activities known are studies and development works which are the subjects of following working papers.

2. Presentation of working papers

The 4 following papers were presented to the Group:

1) WP 17 Enhancement of F/RF-4 Transparency System Bird Impact Resistance.
Ralph J. Speelman - AFFDL - USA.

According to major aircraft damages, severe pilot injuries and increasing bird impact rate, the Air Force Wright Aeronautical Laboratories has initiated a programme to develop an improved transparency system which has a 4 pound - 500 knot capability. Tests were carried out on the windshield, canopy and experimental laminated sidepanels to investigate the capability of the frame.

The baseline birdstrike test results were presented through the use of very interesting post-test photographs and test films.

2) WP 32 Resistance of Windscreen to Bird Impact during Cold Weather.

This study concerns the glass windscreen behaviour to bird impacts in case of heating system failure and cold weather.

The results of comparative tests carried out show that for the windshield under test, there is no significant deterioration in bird impact resistance when the thickness of the interlayers is low.

3) WP 2 Behaviour of Aramid Epoxy Composite Structures to Bird Impact.
A. Brémond - Aerospatiale - France.

This French experimental research programme sponsored by STPA had been the subject of working paper 6 from the 17th BSCE meeting.

The Aramid Epoxy Composite Specimens tested are in relation to the problems encountered in the certification of FALCON 900 and ATR 42 aircraft.

The working paper presents and discusses the experimental results over a period of two years (October 1983 - December 1985).

These results show that

- monolitic plates have a higher capability than the sandwich with the same number of plies,
- in the penetration of the bird a part of kinetic energy is not absorbed,
- during the oblique impacts the bird does not slide on the surface and the penetration energy is the same as in normal impacts.

These last two points reduce the benefit of the use of this material.

However, the experimental work should be considered as giving useful data for the clarification of future problems.

The study must be continued by a systematic compaign of oblique impacts in order to resolve the problem encountered.

4) <u>WP 14</u> Helicopter Bird Strike Resistance.
A. Brémond - Aerospatiale - France.

This paper presented during the Plenary session explained the Aerospatiale philosophy regarding helicopters' bird strike resistance.

The hazard created by bird encounters for helicopter occupants does not account for a large percentage of serious accidents.

However, some cases of cockpit penetration have indeed occurred.

The sensible parts of the helicopter-rotors - windscreens - air intake - must be proved against bird strike effects according to existing regulations.

A film was presented to illustrate typical test conducted on these three sensitive areas of the helicopter.

3. <u>Other Items</u>

Following the WP presentations, a discussion developed about the engines problems:

- Some suggested the creation of a particular working group or sub-group for the engines.

- Some others noted that such a group might not be successful, because the most information about engine bird ingestions is not available to the public.

The Group concluded that the final decision must be transferred to the Steering Committee's responsibility.

4. Terms of Reference - Recommendations

The Group decided to keep the previous terms and recommendations unchanged.

The point (V) concerning the nomination of specific persons to represent the interest of tneir countries has to be raised in order to promote and provide continuity of the work of this Working Group.

BSCE 18

Copenhagen, May 1986

MINUTES OF THE PLENARY MEETINGS 29-30 MAY 1986

1. The meeting was opened by the Chairman who indicated that as Dr. Solman from Canada was not present, he would refer to the pages 103-110 regarding **WP 10, Reduction of Wildlife Hazards to Aircraft.**

2. A. Brémond, France, presented **WP 14, Helicopter Bird Strike Resistance,** followed by a film to illustrate typical tests conducted on the helicopter widescreens, the air intakes and the rotor blades, being the three sensitive areas of the helicopter.

3. J. Thorpe, UK, presented **WP 4, Serious Bird Strikes to Civil Aircraft 1984 & 1985.** He mentioned the Concorde strike on 30 January 1984 at London, Heathrow, the Gambia bird strike on 1 August 1984, the Short SD330 bird strike in Peoria in the US, and the B747 bird strike over north London 27 December 1984, where cabin window 3L was cracked and blood and remains had splattered to first-class passengers. Some slides were further shown.

4. The Chairman indicated that as Dr. V.E. Jacoby from USSR was not present, he would refer to the pages 128-132 regarding **WP 15, Ethological Aspects of Plane's Protection against Birds**, and that questions or comments to the paper should be presented directly to Dr. Jacoby.

5. G. Dupont, Belgium, presented **WP 16, Radar Station Semmerzake, Bird Observation System Semmerzake, further Steps and Improvements.** Some video recordings were further presented.

6. L.-O. Turesson, Sweden, presented **WP 26, Index for Data Base, BSCE Papers and Documents.**

   After discussion it was agreed

that the work regarding BSCE Index of Information should be continued under the supervision of the Steering Committee and restricted to material appearing at BSCE meetings,

that the index paper should be supplied with a foreword indicating that the fact that a paper appears in the index does not imply that the content of the paper has been endorsed by BSCE and that the Steering Committee be asked to discuss the proposed division of the material into the sections and subsections appearing in WP 26.

L.-O. Turesson took on the task to continue the work until further and to include the papers presented at the 18th meeting in order that an up-to-date index could appear in section 2 of the report of the meeting.

7. A. Weaver, Pratt & Whitney Aircraft, East Hartford, Connecticut, USA, presented **WP 29, Bird Hazards to Large Transport Aircraft Engines.**

Opening, he stated that his company welcomed the opportunity given by the letter of invitation of 6 January 1986 to present their view on bird hazard from a safety standpoint. When a bird enters an engine, it often causes damage, and besides it causes an airflow disruption. The reason for this is that the engines are made to handle very large quantities of air per second. This air being mixed with fuel and burning in the middle of the engine, produces energy which turns the rotation components, and thereby produces thrust. As the bird does not burn very well, there is a disruption to the engine. The significant parametre that an engine manufacturer will address to anybody dealing with birds from a structural standpoint is the momentum transfer, the rotation speed, the aircraft speed, and the bird size. His company's findings have, however, shown that the bird size is not very important to the damage as large birds can result in no damage and ingestion of small birds can result in a complete loss of thrust.

Initially, the operator cared about the cost to the repair of the engine. Some of the fan blades in large engines will cost $78,000 per blade, and 40 blades can be scrapped in an engine due to a bird strike.

Of far more interest is, however, the safety consideration. If only a single engine was threatened, the safety risk would be minimum in large transport aircraft as the aircraft is certified to take off with a single engine out, regardless of whether it is a two engine, three or four engine aircraft. The risk factor could be described as P 1 x P 1 x M = risk

factor, where P 1 is the probability for single engine out and M is the probability of multiple engine involvement. In order to get multiple engine involved, you generally need a flock of birds, whereas two single birds operating in the airfield are very unlikely to involve two engines on the same aircraft, but when you start flying into flocks or take-off into flocks of 25-100-1000, the probability that multiple engines will be hit, increases significantly. The engine manufacturer's responsibility is to redress the probability of the engine power loss, and this could be aimed at by changing certain design parametres, especially the fan blades by making the engine more rugged and by making edges thicker. That will, however, increase the fuel consumption and - contrary to the wishes of the airlines - affect the fuel consumption bill significantly.

Another corrective action with the aim to reduce the probability of multiple engine involved would consist in a control of bird flocks on airports. As a programme manager for the bird hazard study funded by the FAA in the USA, he had visited various airports all over the world where there was a significant number of strikes involving multiple birds, significant engine damage or power loss. He mentioned that the FAA is starting another study within the next 3 or 4 months, dealing with the smaller engines in the Boeing 737. The reason for this is that the engines of this aircraft, being underneath the wings, have a fairly high probability of bird ingestion. Besides, this aircraft is operated throughout the world with two very different engine applications, one being a fairly advanced new engine of a large size, and the other of a smaller size and certified in the very early 60'es. The study should determine how the birds perceive those engines and determine if a larger engine will result in more bird strikes. The study is scheduled to continue in the next 2-3 years.

Regarding the corrective action that could be taken on the airport, he mentioned that very few airports have an every day bird flock problem or problem with strikes with single bird which causes a lot of damage. An airport only becomes unsafe when a flock of birds a few days of the year moves in on or near an active runway. The reason for this has, in his opinion, appeared to be that the airport bird control did not know the existence of birds on the runway or near the runway, because there was a sudden change in the bird habits, a change in the weather with the result that the bird flock normally overflying the airport, transiting between roosting and feeding ground, decided to go down and sit on the airport,

such as on foggy days. Consequently, bad weather or weather changes should be the first warning to the airport operator that an unsafe flock may show up.

He finally announced that the manufacturer should be committed to significant improvements regarding the engine, although that will cost the airlines millions of dollars in increased fuel consumption. At the same time, the airport operators must follow suit to identify the periods when flocks of birds will settle down on the runway or right next to the runway because of change of weather etc., and when this is the case and the birds are not removed, to stop the use of such a runway. In order to identify the problem, the airport should establish a traffic control on the runways specifically for birds.

To a question from S. Nastro, Italy, regarding the statement that an airport becomes unsafe when the flock moves in, on or near an active runway, A. Weaver answered that the birds present a safety risk when they are near enough the runway to involve the aircraft at a critical flight phase which is above V 1. In this connection he mentioned that approximately 70% of the bird strikes occurred during the take-off and early climb phase, and approximately 50% of the strikes occurred during the critical phase of the aircraft which is above V 1 and during the initial rotation and climb where a pilot's work load would be outside his experience and training, if he was to lose more than one engine.

To a second question from S. Nastro regarding the statement that birds outside the airport perimetres should not present a threat, A. Weaver answered that his company's data bank has shown that there is only a very low probability that you are going to involve multiple birds after the aircraft has passed over the perimetre fence, and consequently, bird strikes involving safety will only occur when the bird strike takes place at altitudes below 500 ft at speeds in the range of 150-180 kts.

T. Brough, UK, observed that the point at issue was which birds on an airport are a hazard to aircraft. It is obvious that only those birds which are immediately in front of the aircraft are a hazard to the aircraft at the time of impact, but these birds are very often the same birds which at other times of the day are sitting further away from the runway or perhaps the perimetre fences. The staff working on the bird hazard problem has been told that no bird on an airfield is a safe bird, because any bird that is on an airfield, the closer it is to the runway,

the easier it is for it to get to the runway, and the easier it is for it to get to the runway, the greater the probability is that it is going to be involved in a strike at some time. Finally, he observed that most airports exercise bird control on the basis of priorities, and the first priority, which is always accepted, is at the runway which should be cleared of birds first. If one has spare capacity to deal with areas further away from the runway, then those are also attended to.

R. DeFusco, USA, observed regarding Mr. Weaver's equation that the birds mostly involved in bird strikes traditionally are flock birds, such as gulls, heading the list, blackbirds, starlings, and, in the US, waterfowls and lapwings. He maintained that the probability of multiple engine involvement was dependent on the type of birds that were hit. He could not agree that the probability of multiple engine involvement was an independent event, and interpreted this statement as an attempt to shift the emphasis on bird control to the airports and take away the emphasis on the work to be done on the engines.

Answering a question from J.F. Boomans, Belgium, A. Weaver stated that the most perfect bird combat unit action on an aerodrome should never exclude actual observation as to the bird presence on or near a runway before take-off. At some airports, however, he had observed that there was no bird control working on weekends.

J.-L. Briot, France, observed that France had a system which also protected the runways without someone working every day during the hours when the runway was in use. A. Weaver observed that he should look at the number of multiple bird strikes in the various airfields. He intended to include in the contract a study of the airports where multiple birds were involved and what kind of control remedies were in effect at that time.

J. Seubert, USA, agreed with R. DeFusco that we were dealing with accumulative probabilities and also on his point about the flocking birds.

To a question from J. Seubert regarding the problem of transient birds, A. Weaver observed that he would describe transient birds as for instance gulls flying from the roosting place in the morning to the feeding place, which is a garbage dump 20 km away, and in transit happen to use the airfield usually around the perimetres of the airfield. These birds are occasionally struck as single birds, and they present an every day problem hazardous to the airport, but in his opinion not a significant flight safety risk, because they do not involve themselves in multiple

engines, unless something changes, specifically wind changes in particular places, or an aircraft taking-off in another direction.

J. Seubert knew of many examples where transient birds have been a bird hazard problem. He mentioned the airport at Marseilles, the John F. Kennedy Airport and an airport in North Carolina. Consequently, he would never recommend that the airport authorities allow birds to sit in any part of an airport because of their unpredictability, and felt that transient birds potentially can be just about as much a hazard as birds on the airport and in some cases more of a hazard, because the birds are flying across the runway in a flight line like that of blackbirds and starlings. Finally, he stated that the engine manufacturers should make their contribution to minimize the bird hazard problem.

A. Weaver maintained that although transient birds can result in multiple engine strikes, the probability was very low based on the company's study and collection of data.

J. Thorpe, UK, mentioned that observations made at Heathrow Airport had shown that there are as many bird strikes at night in proportion to the number of flight movements as there are in daytime. The myth that birds do not fly at night must be ignored, at least regarding European birds. He asked which of the three large fan engines was the heaviest and which of the three large fan engines was best able to take damage.

A. Weaver maintained that statistics had shown that bird strikes were a daytime hazard, although he was aware that birds do operate at night, and he was also aware of incidents where multiple birds had been struck at night. In his opinion, however, the airport operators should make the greatest efforts in the daytime.

T. Brough, UK, gathered from the statement made by A. Weaver that the only remedy to avoid bird strikes during foggy conditions would be to stop flying the aircraft under these conditions, as detecting birds on the airfield during fog would be rather impossible.

A. Weaver maintained that vehicles should be put down the runway before take-offs in foggy conditions.

8. B. Bruderer, Switzerland, presented the Chairman's Report from the **Radar Working Group**, cf. pages 426-428.

The following recommendations were adopted by the meeting:

a) The Working Group recommends that Finland and the Soviet Union should continue to improve the mutual exchange of actual radar information on mass migration on waterfowl in areas of common interest.

b) The Working Group expressed the wish that the booklet "Use of Radar for Bird Strike Prevention" should be prepared for the next meeting of BSCE.

At the request of B. Bruderer, the meeting appointed L.S. Burma, the Netherlands, as chairman of the Radar Working Group and B. Bruderer, Switzerland, as vice chairman of the said Working Group.

9. **Working Group Aerodrome.** The Chairman's Report was presented by H. Helkamo, Finland, cf. pages 423-425.

After discussion which concentrated on the item of a revision of the green booklet, it was agreed

a) that the Working Group chairman continues to obtain answers from the countries which till now have not answered his request as to new information, and re-cast the presentation of the information,

b) that the Working Group chairman thereafter will produce a draft text to be finalized within 12 months,

c) that the chairman through correspondence with the chairman of the national committees in the countries participating in the work of BSCE form a sub-group consisting of no more than 8-10 persons to go through his draft and decide how to continue the work, the Federal Republic of Germany and Belgium having declared their interest and willingness to participate in the work, and

d) that the 3rd edition of the booklet be prepared for presentation at the next BSCE meeting in Madrid 1988.

10. **Working Group Analysis.** The Chairman's Report on the activities of the Working Group Analysis was presented by J. Thorpe, UK, cf. pages 417-422.

This report reflects the below discussions, especially regarding whether a civil strike is ON or NEAR an airport and the report of the Sub-Group on Feather Identification.

The discussion primarily concentrated on the criteria in defining whether a civil strike is ON or NEAR an airport or EN ROUTE. The original pro-

posal of J. Thorpe was to define 1000 FT down to 200 FT on approach as being NEAR an airport, and 500 FT to 1500 FT on climb as being NEAR an airport, but discussions during the meeting in the Analysis Working Group resulted in a switch to 2500 FT in both cases. Representatives from the Federal Republic of Germany and the USSR were in favour of considering bird strikes occurring below 2500 FT both on approach and on climb as being NEAR an airport, this figure taking into account the definition of an Aerodrome Traffic Zone whereby it extends to 2500 FT above ground level.

Representatives from the following countries: Belgium, Denmark, Finland, France, Spain, Switzerland, UK, and the representative from IATA, however, were in favour of considering a bird strike above 1000 FT on approach and above 1500 FT on climb as being EN ROUTE, and it was finally agreed to comply with these criteria.

After further discussion, it was agreed that the criteria should only concern civil strikes and not military strikes due to the flight level of military aircraft.

J. Widdall, ICAO, indicated that the criteria would be published in the metric form by ICAO, and the ICAO secretariat would convert the figures and round them off in accordance with ICAO Annex 5.

Subsequently, the following recommendations were adopted by the meeting:

1) All Working Group members are reminded that details of strikes to their own countries' aircraft which occur outside their own country, should be sent to the relevant person in the country in which it occurred.

   NOTE: A list of names and addresses is to be provided.

2) All members should use the following criteria in defining whether a civil strike is ON or NEAR an airport:

	CLIMB	APPROACH
ON	0- 500 FT	200- 0 FT
NEAR	501-1500 FT	1000-201 FT
EN ROUTE	1501 FT and above	1001 FT and above

3) Maintenance personnel should be reminded that whenever evidence is found of a bird strike, this should be reported on the bird strike reporting form, and any feathers or remains be sent to the appropriate person for analysis.

4) BSCE analysis of 1985 data incorporating ON, NEAR and DAMAGE be sent by 1st November 1986 to

   - J. Thorpe, chairman, for civil analysis
   - Dr. J. Hild for military analysis

   NOTE: Details of any serious incidents to civil aircraft should be sent to the working group chairman as soon as possible after the event.

11. Sub-Group on Feather Identification.

The rapporteur's report on the activities of the sub-group was presented by R. Laybourne, USA, who informed the meeting that the Sub-Group has had its first meeting with about 15 members in attendance. The Group discussed the variations of the microscopic structure of the down of several species of European birds and methods of preparation of the specimens for scanning electronic microscopic study. It was agreed to exchange information on feather identification and to ask each country to let the group know who in each country is doing the feather identification.

12. Sub-Group on Low-Level Military Aircraft.

The rapporteur's report, cf. page 431, was presented by Col. E. Schneider, Denmark.

Col. Schneider informed the meeting that the Sub-Group was formed on a suggestion from the Steering Committee meeting in October 1985, and the purpose for the Sub-Group was to put more emphasis on the problems which low-level military aircraft encounter regarding bird hazards.

After some discussion, the Sub-Group agreed on the following recommendations:

1. Forming of a Sub-Group

   The Group decided neither to form a Sub-Group nor a Working Group. Instead, the Bird Movement Working Group was asked to put more emphasis on the bird hazard to low flying military aircraft.

2. Consequently, the Terms of Reference to the Bird Movement Working Group should be amended with an addition as follows:

   "and develop preventive measures to minimize the bird hazard to low flying aircraft".

After the Sub-Group meeting, Col. Schneider had received a new suggestion for the change of Terms of Reference of the Bird Movement Working Group, and the new suggestion has the following wording: "and develop measures to identify, monitor and publish bird hazards specific to low flying aircraft".

13. **Working Group Bird Movement.**

The Chairman's Report on the activities of the Bird Movement Working Group was presented by J. Hild, Federal Republic of Germany, cf. pages 429-430.

During the discussion, J.F. Boomans, Belgium, observed that at this stage only Belgium is employing radar information as to the establishment of measures and indication of bird concentration and bird movement by radar.

To a suggestion from Lt.Col. B. Martinsson, Sweden, to form a special group to deal with military bird strike problems, Col. E. Schneider, Denmark, observed that many of the working groups of BSCE are taking care of bird strike to low flying military aircraft, such as the Radar Working Group, as in many countries there only exist military radars, and the bird warning system is primarily manned for military aircraft, but also for low-level general aviation aircraft. Further, he observed that the concern of B. Martinsson could be taken care of by changing the terms of reference for the Bird Movement Working Group, and in his opinion the information asked for by the airforces would be achieved if the airforces would put more emphasis in the work of BSCE and the various working groups.

A proposal from B. Larsson, Sweden, to change the name of this working group to read "Bird Movement and Low-Level Flight Working Group" was accepted.

Finally, the above recommendations, including the change of title of the working group, were adopted by the meeting with some changes which are reflected in the Chairman's Report, cf. pages 429-430.

Finally, J. Thorpe, UK, asked as rapporteur regarding WP 29 the national committees in each country to hand over this WP to the national representatives or pilots' group to get an opinion on the necessity to have changes in these suggestions to make this a suitable European document

and to forward the comments to him in a few months' time, preferably by 1 September 1986.

14. **Working Group for Structural Testing of Airframes.**

The Chairman's Report on the activities of the Working Group for Structural Testing of Airframes was presented by P. Chalot, France, cf. pages 437-439.

The recommendation to keep the previous terms and recommendations unchanged were adopted.

Further, it was agreed regarding a suggestion from R. Wegmann, Sweden, to create a special Sub-Group for engines and that the BSCE Chairman address appropriate persons in the countries asking their views for the usefulness of either extending the Working Group to include a study of the engines, taking into account the confidential commercial nature of much of the information asked for, or to form a Sub-Group to deal with the subject. Before this will be done, the chairman of the Working Group Structual Testing will provide the BSCE Chairman with the proper addresses and the relevant information.

15. At the request of the Chairman, J. Widdall, ICAO, informed the meeting as follows regarding **Harmonization of ICAO Documentation on Bird Hazards:**

The amendment proposed was initiated by Denmark, Norway and Sweden, and later endorsed by Belgium, the Netherlands and Switzerland. The paper was considered by the Air Navigation Commission at the 16th meeting of its 110th session on 4 November 1985, and during this meeting the paper received strong IATA support. The Air Navigation Commission had shown great interest in the material and asked the secretariat of ICAO to reflect these discussions in the amendment proposals when preparing them for circulation and to re-submit the material to the Air Navigation Commission. The ICAO secretariat paper was again considered by the Air Navigation Commission on 25 March 1986. At that meeting the Air Navigation Commission made some editorial changes and instructed the secretariat to circulate the material to States and interested international organizations for comment. (State letter has been issued on 21 July 1986 asking for a reply to reach Montréal by 31 October 1986). The Air Navigation Commission would review the material again in the light of comments received, probably towards the end of 1986. The proposals would then follow

the due processes through the Council. Most probably, it would then be circulated to states and organizations again, but this time in the form of an amendment to Annexes 14 and 15. This would probably be completed towards the end of 1987 and, unless a majority of Contracting States dissented, the amendments would then be formally circulated as definitive amendments to those documents.

16. Regarding the actual status of the ICAO Bird Strike Information System (IBIS), J. Widdall informed the meeting that the manual on the ICAO Bird Strike Information System, Doc. 9332, was being revised on the basis of the discussions held by the advisory group in June 1985. It was expected that the documentation would be published in early 1987.

17. Regarding ICAO workshops on bird hazards to aircraft, the Chairman informed the meeting that there has been a workshop in Bangkok attended by the liaison officer, Vital Ferry, Dr. Hild and W.S. Schabram from the Federal Republic of Germany. J. Widdall informed the meeting that another workshop was planned to take place in South America at the end of this year or perhaps early next year and in the ICAO office in Nairobi in Kenya in late 1987 or early 1988. The ICAO secretariat considered the Bangkok workshop to have been a particularly successful workshop. The contribution which the BSCE team made to the meeting was very much appreciated.

18. **Other cooperation with ICAO.**

J. Widdall informed the meeting that the proposal of the six states, cf. 15 above, went beyond the two Annexes 14 and 15 and touched upon the following three ICAO manuals, Doc. 9137 - Airport Services Manual, Part 3 - Bird Control and Reduction, Doc. 9184 - Airport Planning Manual, Part 2 - Land Use and Environmental Control, and finally Doc. 8126 - Aeronautical Information Services Manual. In this connection J. Widdall informed the meeting that the standards and recommended practices in the Annexes of ICAO are issued by the Council under Article 37 of the Chicago Convention, whereas the manuals are published under the authority of the Secretary General and contain guidance material rather than agreed standards and recommended practices. As a result of the proposal of the six states to amend these manuals, the ICAO secretariat intended to make a start with reviewing and revising Doc. 9137, Part 3, and on behalf of ICAO J.

Widdall invited BSCE's active cooperation and assistance in this matter, assisting ICAO in the first instance with the preparation of detailed amendment proposals for Doc. 9137, Part 3.

The Chairman was in favour of discussing the ICAO invitation to cooperate and assist in revising the manual in a Steering Committee meeting, and the meeting agreed to that.

19. **EEC Council Directive on Bird Conservation. Actual Status of the Implementation.**

S. Eis, Denmark presented **WP 20, a Report by the Danish Wildlife Authority on permissions granted in 1985 concerning deviation from the general rules of hunting and capture of birds in the Act of Hunting and Wildlife Administration,** in which the Council Directive of April 2, 1979 on the Conservation of Wild Birds has been incorporated. According to Danish national legislation, all airports have to report to the Wildlife Administration on the number and species being shot at the airports. In the report the figures tell how many birds divided into species that have been shot in the period 1 April 1984 - 31 March 1985. The Danish Wildlife Administration does not find that the figure in any case is alarming in relation to the population of the species involved.

The Chairman was not aware that other countries than Denmark has answered the question from the EEC, but it was agreed to retain the recommendation from the previous meetings that all EEC contries should keep the Cairman and the liaison officer informed of the report sent to the EEC Commission and to keep contact with the Chairman and the liaison officer in case the EEC Commission should promote actions in the field affected by BSCE recommendations.

20. **Cooperation with ECAC.**

The Chairman informed the meeting that no further development had taken place since the adoption at the 13th intermediate session of ECAC of a recommendation to make use of the BSCE booklet, Some Measures used in Different Countries for Reduction of Bird Strike Risk around the Airport. ECAC, however, holds stocks of that document, both in English and in French, and distribute it on request.

21. **Cooperation with IATA and other Organizations.**

E. Thrane, IATA, stated that IATA takes great interest in the work of BSCE and appreciates the invitation to participate in the meeting as observer. Although a review of this 18th meeting had given him the impression of a well-planned and smoothly running conference, he had, however, the impression that the results achieved lately were rather meagre. We are still using old methods and devices for scaring birds away at the airports, such as using pyro-technics, acoustics and shotguns, although it was widely acknowledged that bird habits could not be beaten and migration routes not be changed, he looked forward to a day when something could be done about the migration routes and something about the habits of the bird, as mankind has shown to be able to reverse the streams of large rivers or to tow huge icebergs from Greenland down to the Mediterranean for supplying fresh water. He hoped that the good work done so far would be continued, realizing that there was a common sort of responsibility for minimizing the bird risk at the airport. The national civil aviation administration has the responsibility for issuing regulations and seingto it that they are complied with. The airport management naturally has the real defactual responsibility for having the birds dispelled from the airport. Biologists have the responsibility for continuing their study in the bird behaviour, and other experts have the responsibility for finding new methods, new ways of keeping the birds off the airport, and the airlines have the responsibility to stress to their pilots, their pilots-in-command, that they do proper bird strike reporting. Although solutions will not make it impossible to have bird strikes, he felt that a lot of improvement in this field was needed.

The Chairman remarked that BSCE as such shared IATA's hope and took the above remarks ad notam. In this connection he drew the attention of the meeting to a proposal from the 17th BSCE meeting according to which a better follow-up of new items appearing in the working groups is necessary. The meeting agreed to retain this proposal.

22. **Election.**

The meeting approved the following elections:

L.S. Burma (Netherlands) as chairman of the Radar and Other Sensors Working Group.

B. Bruderer (Switzerland) as vice chairman of the same Group.

J. Becker (Federal Republic of Germany) as vice chairman of the Bird Movement and Low-Level Flight Working Group.

P. Chalot (France) as chairman of the Structural Testing Working Group.

R. Peresmempo (Italy) as vice chairman of the same Group.

B. Larsson, Sweden, observed that the Swedish Airforce was of the opinion that there was an overwhelming majority of civil representatives to the Steering Committee with only Col. Schneider, Denmark, representing the military side, and he announced that the Swedish Airforce at the coming meeting in Madrid would come up with a proposal to enlarge the Steering Committee by an airforce man and besides an active pilot.

E. Schneider, Denmark, observed that the military representation had been discussed in the Steering Committee and that the Steering Committee agreed to the idea to have another military representative as a member, but until now the committee has not had any suggestions, and this is primarily because of the rotation of the military persons. Besides, it should be taken into account that, although being a civilian, J. Hild, Federal Republic of Germany represents the German Airforce.

23. The Mike Kuhring Award.

H. Dahl explained the background for the Mike Kuhring Award which was first issued at the meeting in the Hague in October 1979. At the Steering Committee meeting last autumn, it was agreed to change the procedure in order to be able to hand over the diploma at the same meeting where it was conferred on the recipient.

Due to a mistake, the award decided upon at the Moscow meeting had not been handed over to the recipient, **Lars-Olof Turesson,** Sweden.

H. Dahl presented the diploma to Lars-Olof Turesson, and declaring that the award was conferred on Lars-Olof Turesson in recognition of his long, ever inspiring and never tiring work for the flight safety and especially for his activities during his six years of service as chairman of BSCE.

Then H. Dahl presented the 4th Mike Kuhring Award to **Eilif Schneider,** Denmark, declaring that the award was conferred on Eilif Schneider in recognition of his dedicated work for the flight safety from the very beginning of BSCE and especially for his ability to define aims and reach

them during his years as chairman and acting chairman in many BSCE meetings.

Next H. Dahl presented the 5th Mike Kuhring Award which had been conferred on **R.R. Twijzel**, the Netherlands, in recognition of his long work for the flight safety and especially for his activities as chairman of BSCE where his ability to look into the future enabled him to create the still existing structure of BSCE.

As Col. Twijzel was not present, Col. Schneider undertook the task to forward the diploma to Col. Twijzel.

After a proposal by H. Dahl, on behalf of the Steering Committee, it was decided that the 6th Mike Kuhring Award be conferred on **Victor E.F. Solman**, Canada, in recognition of his activities during the whole existance of BSCE where, as a charismatic councellor, he has been an active and inspiring link between the activities in Canada and in the European countries.

H. Dahl would take care that the diploma be forwarded to Vic Solman.

24. **Planning for Future Meetings of BSCE.**

H. Dahl announced that the 19th BSCE meeting would be held in Madrid in the week that starts on 23 May 1988, and that the 20th meeting of BSCE would take place in Helsinki, Finland, in the autumn of 1989. After an invitation from the participants from Israel, the 21st meeting would take place in the spring of 1991 at a place near Tel Aviv in Israel.

25. **Other Matters.**

On behalf of the US delegation, R. Speelman declared the US delegation's support of the increasing emphasis on low-level military application of flying procedures.

26. **Termination of the Meeting.**

H. Dahl expressed the gratitude of himself, the Steering Committee and all participants in the meeting for the work done by the secretariat of the meeting and presented gifts to each member of the secretariat.

On behalf of the participants, J. Hild thanked the Danish delegation for organizing and leading the 18th BSCE meeting in Copenhagen, thanked SAS for the ladies's excursion, the Danish Civil Aviation Administration for

the excursion to the Open Air Museum and the Airport Authorities for organizing the Saltholm excursion.

H. Dahl finished by declaring the meeting closed.

27. **Actions.**

Chairman of BSCE:

1. Based on the recommendations in the Structural Testing Group, writes to all countries represented at the BSCE meeting requesting nomination of specific persons to represent the interest of both civil and military authorities and manufacturers in their countries in order to promote and provide continuity of the work of the Structural Testing Working Group (cf. page 396 from the Rome meeting and the recommendation from the Copenhagen meeting).

2. Upon receipt of the necessary information from the chairman of the Structural Testing Group, writes to appropriate persons in the countries asking for their views on the usefulness of either extending the Working Group to include a study of the engines taking into account the confidential commercial nature of much of the information asked for or to form a sub-group to deal with the subject.

3. Upon finalizing by L.-O. Turesson of the BSCE Index of Information, calls a meeting in the Steering Committee to discuss the division of the material into sections and sub-sections.

4. Initiates a discussion within the Steering Committee on the invitation by the ICAO secretariat to cooperate actively and assist the secretariat in revising Doc. 9137 - Airport Services Manual, Part 3 - Bird Control and Reduction.

L.-O. Turesson:

Extends the information in the BSCE WP 18/26, Index of Information, taking into account the WPs presented at the Copenhagen meeting.

J. Thorpe:

Collects answers from the countries with comments on WP 18/29, Avoiding Bird Strikes.

R. Laybourne:

Initiates an exchange of information on feather identification asking each country to let the Sub-Group on Feather Identification know who in each country is doing the feather identification.

V. Ferry:

1. Upon receipt of the material collected by J. Thorpe, initiates discussion within the Communication Working Group regarding bird strike avoidance and post-strike procedures for helicopters, light aircraft and military aircraft, including collection of input of the duly appointed representatives of appropriate international regional organizations such as AEA, IATA, ICAO, IFALPE, ISFATCA, IAOPA, and AAACC.

2. Initiates the work to develop regional procedures for the rapid collection and transmission of information on those bird hazards to aviation which cannot be predicted in advance and which cannot be quickly disposed by the available means, including a formal development of a civil BIRDTAM message and its implementation on a trial basis in coordination with the European regional office of ICAO.

3. Initiates the work to collect data encompassing methods used for transmission of bird hazard information and flight procedures suggested to reduce or avoid bird strikes for publication along the lines selected by the booklet "Some Measures Used in Different Countries for the Reduction of Bird Strike Risks around the Airport.

L.S. Burma:

Initiates the work to prepare a booklet "Use of Radar for Bird Strike Prevention" for the next meeting of BSCE.

H. Helkamo

1. Obtains answers from the countries which till now have not answered his request on a revision of the green booklet.

2. Upon receipt of the answers above, produces a draft text to be finalized within 12 months.

3. Through correspondance with the chairmen of the national committees in the countries participating in the work of BSCE, forms a sub-

group consisting of no more than 8-10 persons to go through the draft above and decide how to continue the work.

4. Upon finalizing the work mentioned under 3, prepares a 3rd edition of the booklet for presentation at the next BSCE meeting.

Members of the Working Group Bird Movement:

Revise the existing national maps and inform the chairman of the Working Group Bird Movement accordingly. Deadline 1 January 1988.

Members of the Communications and Flight Procedure Working Group:

Comment on WP 18/29, Avoiding Bird Strikes, and inform J. Thorpe accordingly.

Members of the Analysis Working Group:

1. Forward details of strikes to their own country's aircraft which occur outside their own country to the relevant person in the country in which it has occurred.

2. Use the following criteria in defining whether a civil strike is on or near an airport:

	CLIMB	APPROACH
ON	0- 500 FT	200- 0 FT
NEAR	501-1500 FT	1000-201 FT
EN ROUTE	1501 FT and above	1001 FT and above

3. Remind maintenance persons that whenever envidence is found of a bird strike, this should be reported on the Bird Strike Reporting Form, and any feathers and remains be sent to the appropriate person for analysis if deemed necessary.

4. Send BSCE analysis 1985 data encorporating on, near and damage by 1 November 1986 to J. Thorpe for civil analysis and J. Hild for military analysis.

5. Send details of any serious incidents to civil aircraft to J. Thorpe as soon as possible after the event.

Chairmen of national bird strike committees:

1. Inform J. Hild of names and members for active cooperation within the Bird Movement Working Group.

2. Inform about sanctuaries, national parks of ornithological importance and moist areas of international importance, for drawing up a corre-

sponding European map upon a questionnaire forwarded by J. Hild and inform J. Hild on their view as to a need for publication of such maps.

3. Draw up airport vicinity maps in close cooperation with airport authorities and according to special guidelines upon request by J. Hild. Deadline 1 Januar 1988.

4. Inform J. Thorpe on adaption of the material contained in WP 18/29 to BSCE needs.

5. Inform the chairmen of BSCE of the answers to EEC on the EEC Council Directive on Bird Conservation (only applicable to EEC countries).

Chairmen of the national bird strike committees in Finland and Russia:

Take care that the mutual exchange of actual radar information on mass migration of waterfowl in areas of common interest is continued.

BSCE 18
Copenhagen, May 1986

R E C O M M E N D A T I O N S

Aerodrome Working Group

1. The Committee recommends to EEC Member States

   (a) to keep the chairman and the liaision officer informed of the report sent to the EEC Commission about the implementation of the directive 79/409,

   (b) to maintain contact with the chairman and the liaison officer in case the EEC Commission will promote action in the field affected by the BSCE recommendations.

Analysis Working Group

1. A sub-group be set up to pursue the work on the identification of bird remains with emphasis on microscopic remains of feathers. Mrs. Laybourne from US acts as rapporteur.
2. A special investigation should be carried out on the incidents where more than one engine was struck on take-off by birds with particular emphasis on bird species, number of birds striking the engine, and probable thrust loss.
3. ICAO be again encouraged to make some refinements to the IBIS programme in order to achieve full potential from this valuable system.

Bird Movement Working Group

1. Maps on bird concentration and migration methods be revised.
2. Risk maps for airport facility areas be drawn up.

Communication and Flight Procedures

1. Data encompassing methods used for transmission of bird hazard information and flight procedures suggested to reduce or avoid bird strikes to be published be collected.
2. Standardization of flight procedures for helicopters, light aircraft and military low-flying aircraft be contemplated.

Radar Working Group

a) Further efforts towards coordination and collaboration in

   (1) the field of radar research in bird migration

   (2) in the operational use of radar information for bird strike prevention.

b) Promotion of a mutual exchange of radar information on actual mass migration of waterfowl between Russia and Finland.

c) Inclusion of Austria in the radar chain along the Alps.

Structual Working Group

1. Bird strike tests on Aramid Epoxy Composite Structures be done.
2. Tests to study low-temperature effect on the resistance of various wind shield glasses.
3. Testing of NIDA and shock absorber materials' bird strike resistance.

BSCE 18
Copenhagen, May 1986

TERMS OF REFERENCE OF BSCE

Bird Strike Committee Europe consists of civil and military participants from Europe with a common interest in the bird strike problem. Attendance is open to participants from other parts of the world.

The Bird Strike Committee Europe shall:

a) collect, analyse and circulate to all concerned data and information related to the bird strike problem in the European region;

Note: This data and information should include the following:

1. Civil and/or military data collections and results of analyses on bird strikes to aircraft.

2. Results of any studies or examinations undertaken by states in the various fields related to the bird problem.

3. Any information available in the field of design and structural testing of airframes related to their resistance to bird strikes.

4. Any other information having a bearing on the bird strike question and the adding to the various problems involved.

b) study and develop methods to control the presence of birds on and near aerodromes;

c) investigate electro-magnetic wave sensing methods (e.g. radar, invisible light, etc.) for observing bird movements;

d) develop procedures for the timely warning of pilots concerned where the existence of a bird hazard has positively been established;

e) develop procedures, if appropriate, for the initiation by air traffic control of avoiding action where existence of a bird hazard has positively been established;

f) develop procedures enabling a quick and reliable exchange of messages regarding bird hazard warnings;

g) develop any material (e.g. maps, back-gound information, etc.) intended for inclusion in Aeronautical Information Publications;

h) aim at a uniform application, throughout the European region, of the methods and procedures and the use of material developed in accordance with b) to g) above, provided suitable trials have proved their feasibility, and monitor developments in this respect.

TERMS OF REFERENCE OF THE STEERING COMMITTEE OF BSCE

1. A Steering Committee is appointed as a policy steering committee to assist the chairman of BSCE between and during meetings. The main tasks of the Steering Committee are:

   a) To study, evaluate and select papers to be presented to the working groups and the Plenary meeting.

   b) To participate during each BSCE meeting in preparing recommendations, proposals for text for inclusion in the Report, and, where necessary, any other paper of a general nature.

   c) To participate at the end of each BSCE meeting in preparing the Report of the meeting and to prepare the follow-up action of recommendations.

   d) To assist the BSCE chairman in formulating BSCE Policy Statements.

2. The Steering Committee should consist of:

   (i) The BSCE chairman and vice chairman
   (ii) The previous BSCE chairman, if possible
   (iii) The chairman of each BSCE working group
   (iv) The observer from ICAO
   (v) A representative of the host state.

3. The conclusions of the Steering Committee should be presented to the Plenary meeting of BSCE for action. Alternatively, the members of BSCE should be kept informed of the activities of the Steering Committee between full meetings of BSCE.

4. The BSCE chairman acts also as the chairman of this committee and is entitled to call meetings of the Steering Committee as and when required during BSCE meetings.

TERMS OF REFERENCE OF THE CHAIRMAN

5. The chairman is elected by the Committee for a term covering two periods between meetings, i.e. three years.

TERMS OF REFERENCE OF THE VICE CHAIRMAN

Responsibilities:

1. To assist the chairman in carrying out the work of BSCE.

2. To take over the responsibilities of the chairman in the event of the chairman being unable to carry them out.

3. The represent BSCE when so designated by the chairman.

BSCE 18

Copenhagen, May 1986

SOME EVENTS

On Tuesday, a whole-day ladies' tour was sponsored by Scandinavian Airline Systems and took the participants to the castles of North Sealand. On Wedensday, the City of Copenhagen gave a reception in the Town Hall of Copenhagen. On Thursday afternoon, 2 tours were arranged, one to the island of Saltholm and the Airport of Copenhagen, the other to the Open Air Museum north of Copenhagen.

BSCE 18
Copenhagen, May 1986

LIST OF PARTICIPANTS

AUSTRIA	MATSCHNIGG, Günther
BELGIUM	BOOMANS, J.F.
	DELANGHE, L.
	DUPONT, G.
	HAERYNCK, Marc
	ROOSELEER, M.T.
CANADA	HAYES, D.R.
CZECHOSLOVAKIA	SANTRUCEK, Bohuslav
DENMARK	DAHL, Hans
	EIS, Søren
	GLENNUNG, A.M.
	JUNKER-HANSEN, Bent
	LIND, Hans
	LUNDBERG, M.C.
	NIELSEN, V.B.
	SCHNEIDER, E.P.
	THRANE, Erik K.
FEDERAL REPUBLIC OF GERMANY	BECKER, Jürgen
	BEUTER, Karl J.
	BRUSSOW, Dieter
	FUSSMAN, Gerhard
	FURBETH, Herbert
	HILD, Jochen
	HOFFMANN, Ottokar
	MUNTZE, Thomas
	SCHABRAM, Walter J.
	SINDERN, Christoph

FINLAND	AHO, Ari
	HELKAMO, Heiko
	KIRJONEN, Seppo
	STENMAN, Olavi
FRANCE	ALBERT, Jean-Claude
	ATTIG, A.
	BESSE, Jean
	BRÉMOND, Alain
	BRIOT, Jean-Luc
	CHALOT, Pierre
	CONRIE, Jean-Claude
	DEVEAUX, Jean-Pierre
	GAUTIER, Francois
	NEVEUX, Christiane
	SOUQUET,
IRELAND	MACDONALD, R.A.
ISRAEL	AGAT, Ilana
	SUARETZ, Shalom
ITALY	AIDO, Scognamilio
	BARRA, Bruno
	FERRARI, A.
	LUZZATI, Carlo
	NASTRO, S.
	SEPE, Francesco
NETHERLANDS	BAKKER, C.
	BIEMOND, J.
	BROM, T.G.
	DEKKER, A.
	KLAVER, A.
	TEIJGELER, E.K.
	VAN WESSUM, H.J.D.
NEW ZEALAND	CAITHNESS, T.A.
NORWAY	BENTZ, Per-Göran

SPAIN	ESPINOSA, Juan Trinidad
	HERRERIA, Gabriel Diaz de Villegas
	RUIZ, Juan
	VILLUENDAS, Antonio
SWEDEN	ANDERSSON, Sven-Harald
	CARLSSON, Åke
	HIRSCHFELD, Erik
	LARSSON, Bertil
	MARTINSON, Bengt
	TURESSON, Lars-Olof
	ULFSTRAND, Astrid
	WEGMANN, Rolph
SWITZERLAND	BRUDERER, Bruno
	FRITZ, Jacques
	UNKAUF, Rudolf
UNITED KINGDOM	BROUGH, Trevor
	GROVE, A.D.W.
	SCORER, Tim
	THORPE, John
	TURNER, J. Crawford
USA	BIUINGS, Bert
	DEFUSCO, Russell P.
	LAMB, Neil J.
	LAYBOURNE, Roxie C.
	SEUBERT, John L.
	SHORT, Jeff
	SPEELMAN, Ralph
	THOMPSON, Michael M.
	WEAVER, A.
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	IVANOV, F.G.
	UGARKIN, S.M.
ICAO	WIDDALL, John
IATA	DIETZ, Michael

SECRETARIAT

HANSEN, Jesper Slot Rohr (FKO)
HJULGAARD, Susanne (FKO)
JENSEN, Ulla (SLV)
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PRINTED BY
DIRECTORATE OF CIVIL AVIATION